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1. Introduction

1.1 Purpose

This report covers all the flight dynamics activities undertaken in support of the flight operations for the period during Opposition 5 in February/March 1998.

1.2 Definitions, Acronyms and Abbreviations

ATCALC	A collection of attitude calculation utilities
ATTFIT	Program to perform least squares fit to a set of observed attitudes
EAA	Earth aspect angle
COM	Program to generate spacecraft manoeuvre command files
CONJ	Spacecraft on-board program to execute a predefined set of manoeuvre commands at a predefined time interval
Dec	Declination in Earth Mean Equatorial system of 1950
DSN	Deep Space Network
EAA	Earth aspect angle
FD	Flight Dynamics
FDS	Flight Dynamics Sequence
JPL	Jet Propulsion Laboratory
MPF	Manoeuvre Prediction Form
NR	Program for non-routine phase manoeuvre preparation, simulation and command generation
PLPAT4	Program to produce attitude visualisation plots
RA	Right ascension in Earth Mean Equatorial system of 1950
SAA	Solar aspect angle
SEP	Sun-Earth-Probe angle
SPE	Sun-Probe-Earth angle
UTC	Universal coordinated time

1.3 References

- [1] *ULYSSES Flight Dynamics Report, Volume 3: Opposition 2 Manoeuvres*
issue 1, 14-Aug-1992
- [2] *ULYSSES UMCS Replacement - Flight Dynamics Verification and Refamiliarisation Test Report*
ULY-VR-RP-01, issue 1, 27-Mar-1997
- [3] *ULYSSES Flight Dynamics Software Users Manual – Real-Time Attitude Monitor*
ULS-SUM-ATT-RTM, issue 2, 29-Sep-1989
- [4] *ULYSSES Flight Dynamics Software Users Manual – Non-Routine Phase Command Generator*
ULS-SUM-MAN-NR, issue 2, 30-Nov-1989
- [5] *ULYSSES Flight Dynamics Software Users Manual –Command Generation Program*
ULS-SUM-MAN-COM, issue 2, 30-Nov-1989

2. Manoeuvre Planning

2.1 Assumptions

The planning of the manoeuvre strategy and nominal manoeuvre sequence was based on the following assumptions:

1. The Opposition 5 period was defined as that when minimum Sun-Probe-Earth (SPE) angle is less than 1.5° .
2. The maximum allowed Earth off-pointing for the Opposition 5 period was 0.8° .
Initially the off-pointing constraint was set at 0.5° to provide sufficient margin for a downlink bit rate of 2048 bps in order to be able to interleave the transmission of playback with real-time data. Subsequently almost continuous ground station coverage was obtained for the Opposition period which meant that there was no need to record data on-board the spacecraft during periods of non-coverage. Hence the downlink bit rate could be lowered to 1024 bps since there was only the real-time data to transmit and the Earth off-pointing constraint was relaxed to 0.8° .
3. The operating limit for the minimum solar aspect angle (SAA) was 1.5° .
This was a very conservative limit compared to that used for Opposition 2, which was 1.3° (see [1]), to allow for any greater than expected dispersion in manoeuvre performance.

2.2 Manoeuvre Strategy

An avoidance manoeuvre around the Sun and back onto the Earth path was necessary to avoid transgressing the minimum SAA limit during the Opposition 5 period. During Opposition 2, this avoidance manoeuvre was intended to be executed mainly as one single manoeuvre around the Sun without losing the downlink. However such a strategy was not possible for Opposition 5 because the drift rate of the Sun relative to the spacecraft was considerably less than that of the Earth relative to the spacecraft. Instead, the Sun avoidance manoeuvre was split up into a series of short manoeuvres around the Sun at daily intervals - keeping up with the Earth drift to maintain the downlink while avoiding the minimum SAA limit at the same time.

This strategy is similar in principle to that of the on-board CONJ program which was intended to perform Sun avoidance manoeuvres during periods of conjunction by the repeated execution of the same set of manoeuvre commands at a fixed interval. The difference in this case is that the driver for a particular manoeuvre is the optimal target attitude for that particular day.

2.3 Targeting

The procedure to derive the target attitudes for the Sun avoidance manoeuvre sequence is as follows:

1. Determine the exact time of minimum Sun-Probe-Earth angle (SPE).
2. Use program *PLPAT4* to produce a hardcopy plot the positions of the Sun and Earth at daily intervals for a period of ± 5 days around the time of minimum SEP.
3. Determine the optimal opposition attitude, \vec{A}_6 , on the hardcopy plot graphically as follows:
 - a. Draw a normal to the Earth path at day 6, opposition time t_6 .

- b. Intersect the above normal with the SAA = 1.5° cone at time, t=5.5 days = t₆ - 0.5 days to obtain \vec{A}_6 .
- 4. Similarly determine the intermediate target attitudes, \vec{A}_i , for i = 1 to 11 for the other days.
 - a. Draw a normal to the Earth path at day i, t_i.
 - b. Intersect the above normal with the SAA = 1.5° cone at time, t_i - 0.5 days to obtain \vec{A}_i .
- 5. Verify for each attitude \vec{A}_i , that the minimum SAA and maximum EAA constraints are satisfied for the interval t_i - 0.5 days to t_i + 0.5 days.

Steps 3 and 4 in the above procedure may be replaced by a numerical calculation of the attitudes:

For step 3:

- a. $\vec{n}_6 = \frac{\vec{E}_5 \times \vec{E}_7}{\|\vec{E}_5 \times \vec{E}_7\|}$ gives the normal to the \vec{E}_5, \vec{E}_7 plane.
- b. $\vec{u}_6 = \frac{\vec{E}_6 \times \vec{n}_6}{\|\vec{E}_6 \times \vec{n}_6\|}$ is perpendicular to \vec{E}_6 and the Earth path.
- c. Now calculate the intersection of the 90° cone around \vec{u}_6 and the 1.3° cone around $\vec{s}_{5.5days}$.

For step 4, the numerical calculation of the intermediate attitudes, \vec{A}_i , is similar to step 3 as given above.

2.4 Nominal Timeline and Target Attitudes

Using the procedure described previously, the minimum of SEP was determined to be 0.782° and the time that this occurred was 980226:1055 UTC. The manoeuvre times were set to 18:00 UTC for each day for operational convenience. The target attitude for slew 0 was obtained using the program *ATCALC* while those for slews 1 to 11 were obtained graphically as described previously.

A table of the target attitudes for each slew is given in Table 2 and a graphical representation of the Earth and Sun paths and the target attitudes can be found in Figure 1. In order to verify that the target attitudes satisfy the SAA and EAA constraints, the evolution of these parameters were plotted over the Opposition 5 period. These plots can be seen in Figure 2 and Figure 3.

Time (UTC) [yyymmdd:hhmm]	Event	Target Attitude [RA, Dec]	Remarks
980220:0430	Slew 0	341.52°, -12.82°	Slew to Earth pointing attitude before start of Opposition 5 manoeuvre sequence
980221:1800	Slew 1	341.28°, -13.15°	
980222:1800	Slew 2	341.08°, -13.38°	
980223:1800	Slew 3	340.86°, -13.54°	

Time (UTC) [yyymmdd:hhmm]	Event	Target Attitude [RA, Dec]	Remarks
980224:1800	Slew 4	340.65°, -13.62°	
980225:1800	Slew 5	340.43°, -13.68°	Maximum EAA at end of slew
980226:1800	Slew 6	340.20°, -13.69°	
980227:1800	Slew 7	339.97°, -13.68°	
980228:1800	Slew 8	339.72°, -13.63°	
980301:1800	Slew 9	339.49°, -13.55°	
980302:1800	Slew 10	339.25°, -13.44°	
980303:1800	Slew 11	339.00°, -13.29°	Resume routine Earth pointing slews after this manoeuvre

Table 1: Nominal Timeline and Target Attitudes for Opposition 5

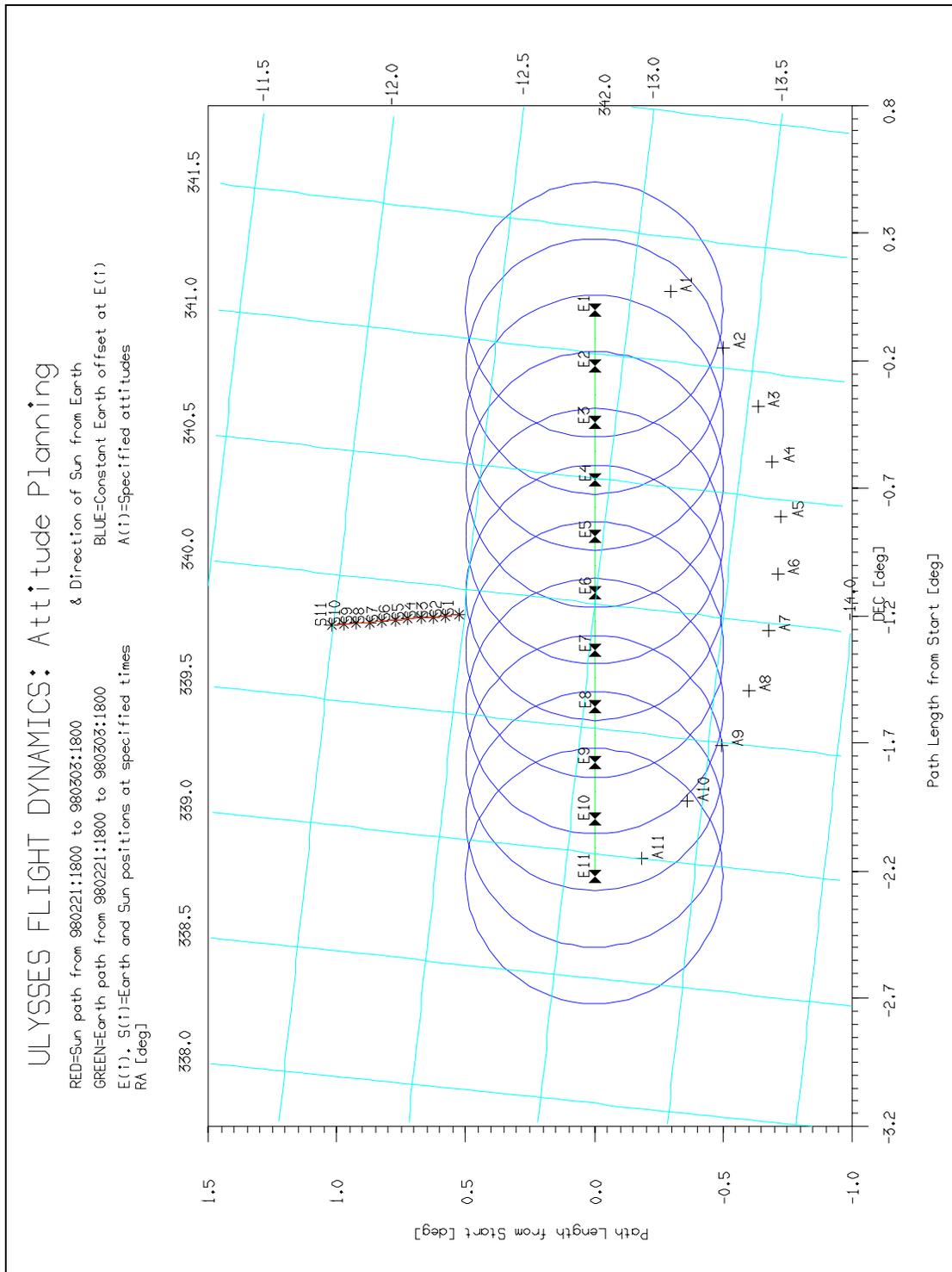


Figure 1: Earth and Sun Paths and Target Attitudes for Opposition 5

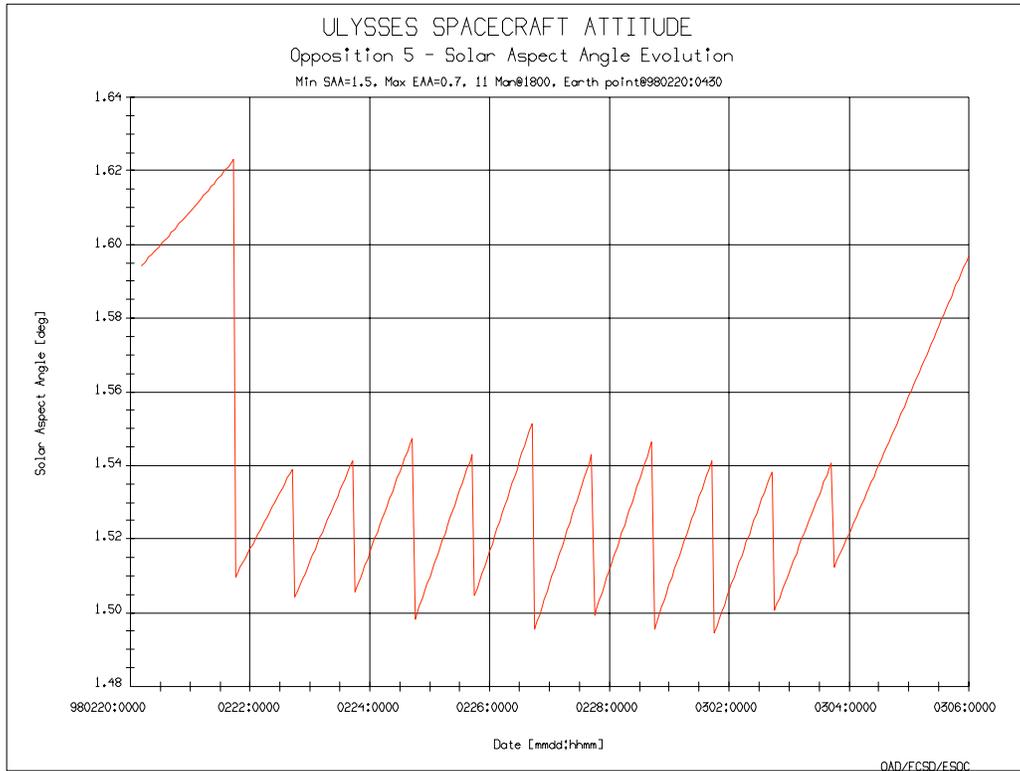


Figure 2: Nominal SAA Evolution for Opposition 5

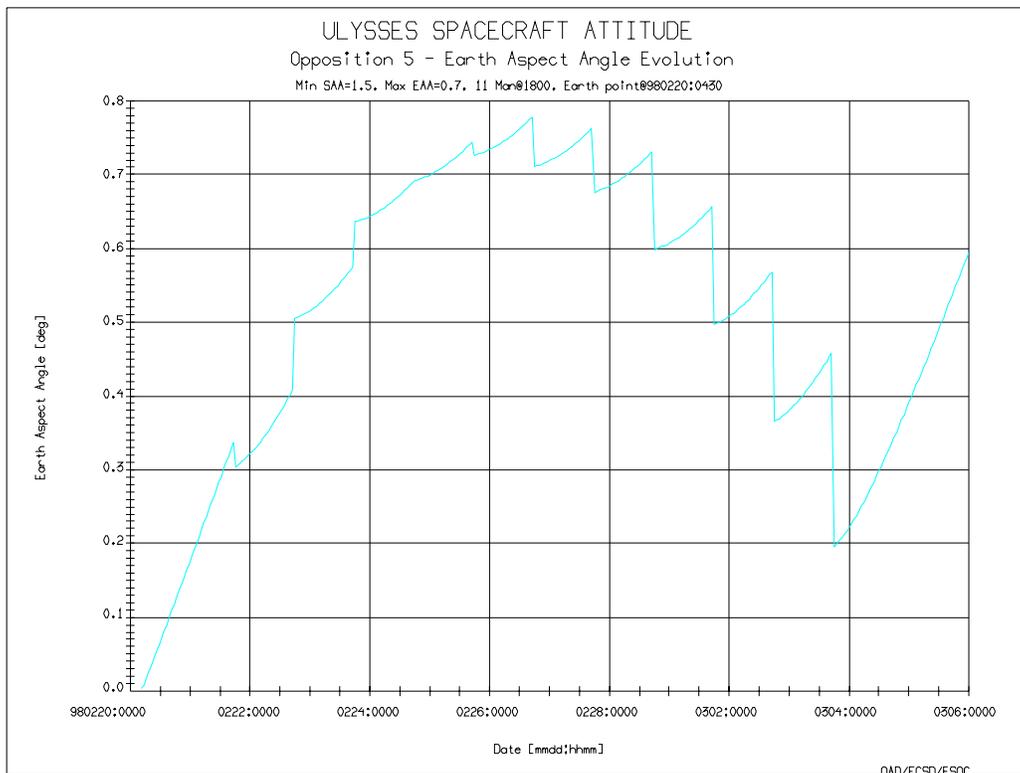


Figure 3: Nominal EAA Evolution for Opposition 5

3. Actual Manoeuvre Sequence

3.1 Summary

A summary of the actual Opposition 5 Sun avoidance manoeuvres is given in Table 2. It should be noted that the slight discrepancies in the planned attitudes and those of the nominal target attitudes in Table 1 are due to discretisation of the thruster pulses.

Manoeuvre, FDS ID	Start & End Times	Attitude [RA, Dec]		SAA		EAA	
		Planned	Actual	Target	Actual	Target	Actual
Slew 0, X868	980220:0430-0437	341.53°, -12.82°	341.50°, -12.83°	1.60°	1.58°	0.01°	0.02°
Slew 1, X869	980221:1929-1938	341.28°, -13.15°	341.28°, -13.20°	1.51°	1.53°	0.31°	0.35°
Slew 2, X870	980222:1929-1935	341.07°, -13.39°	341.08°, -13.42°	1.51°	1.53°	0.51°	0.55°
Slew 3, X871	980223:1959-2006	340.87°, -13.54°	340.85°, -13.58°	1.51°	1.53°	0.64°	0.67°
Slew 4, X872	980224:1929-1935	340.65°, -13.62°	340.62°, -13.68°	1.50°	1.54°	0.69°	0.74°
Slew 5, X873	980225:1929-1934	340.42°, -13.68°	340.36°, -13.72°	1.51°	1.52°	0.73°	0.76°
Slew 6, X874	980226:1929-1934	340.21°, -13.69°	340.13°, -13.74°	1.50°	1.54°	0.72°	0.75°
Slew 7, X875	980227:1959-2004	339.96°, -13.68°	339.94°, -13.69°	1.50°	1.52°	0.67°	0.69°
Slew 8, X876	980228:1929-1935	339.73°, -13.63°	339.71°, -13.66°	1.50°	1.53°	0.60°	0.63°
Slew 9, X877	980301:1930-1935	339.48°, -13.55°	339.53°, -13.60°	1.50°	1.54°	0.49°	0.56°
Slew 10, X878	980302:1500-1507	339.25°, -13.44°	339.23°, -13.50°	1.55°	1.56°	0.43°	0.42°
Slew 11, X879	980303:1500-1507	339.00°, -13.29°	339.00°, -13.30°	1.51°	1.52°	0.19°	0.20°

Table 2: Summary of Opposition 5 Manoeuvres

3.2 Manoeuvre Preparation and Command Generation

The manoeuvre preparation and command generation tasks were executed outside of the Routine Phase Management System (RPMS) since this series of manoeuvres are *non-routine* FD operations. The manoeuvre preparation was carried out using the program NR while the program COM was used to perform the generation of the manoeuvre commands. Unlike previous commands for *non-routine* manoeuvres, the time-tags were not removed.

The manoeuvre preparation outputs in the form of manoeuvre prediction forms (MPFs) for each manoeuvre are attached in Appendix A and their respective telecommands can be found in Appendix B.

3.2.1 Selection of Manoeuvre Execution Times

It can be seen in Table 2 that the times of the actual manoeuvres are different from those given in the nominal timeline in Table 1. Even though 24 hour DSN station tracking coverage was available during the Opposition 5 period, not all the tracking passes had both downlink and uplink capabilities. So the manoeuvre execution times had to be adjusted when the final tracking schedules were released in order to satisfy the following criteria:

1. Manoeuvre only during tracking passes with both uplink and downlink.
2. Allow at least an hour of uplink prior to the start of a manoeuvre in order to obtain sufficient data for pre-manoeuve attitude determination.
3. Allow at least an hour of uplink after to the end of a manoeuvre in order to obtain sufficient data for post-manoeuve attitude determination. Two hours is preferred in order to allow for post-manoeuve nutation damping.
4. No station uplink transfer during the time period defined by criteria 2 and 3 above.

3.2.2 Catalyst Bed Pre-Heating

The catalyst bed pre-heating was conducted just as for the routine Earth pointing slews. The duration was 100 min and the heaters were switched off by a time-tagged command one clock cycle (~32s) before the LV ON and EXECUTE MAN command were loaded.

3.2.3 SAA Deadband Selection

From past experience, it has been found that the Sun datations start to become unreliable at around an SAA of 1.25° . Therefore the setting for the lower SAA deadband must be chosen such that it will permit immediate manoeuvring to a safe SAA attitude should an SAA deadband transgression occur during a Sun avoidance manoeuvre. In other words, it should not be set so close to the limiting SAA of 1.25° in order that there will be a reliable set of Sun datation to perform the emergency safe SAA manoeuvre.

Thus the bit pattern for the lower SAA deadband was chosen to be 88_{hex} . This setting corresponds to an SAA value of 1.294° on XBS1, the operational Sun sensor unit, based on the current spin angle to SAA conversion table. To achieve this, the value for the SAA deadband half-width input parameter for the program *NR* was set to 0.26° .

3.3 Manoeuvre Execution

There were no anomalies during the execution of the Opposition 5 manoeuvres.

A graphical representation of the Earth and Sun paths and the end attitudes of the manoeuvres is shown in Figure 6. Plots of the SAA and EAA evolution during this period can be seen in Figure 4 and Figure 5 respectively. The real-time monitor graphical plots for each manoeuvre are attached in Appendix C.

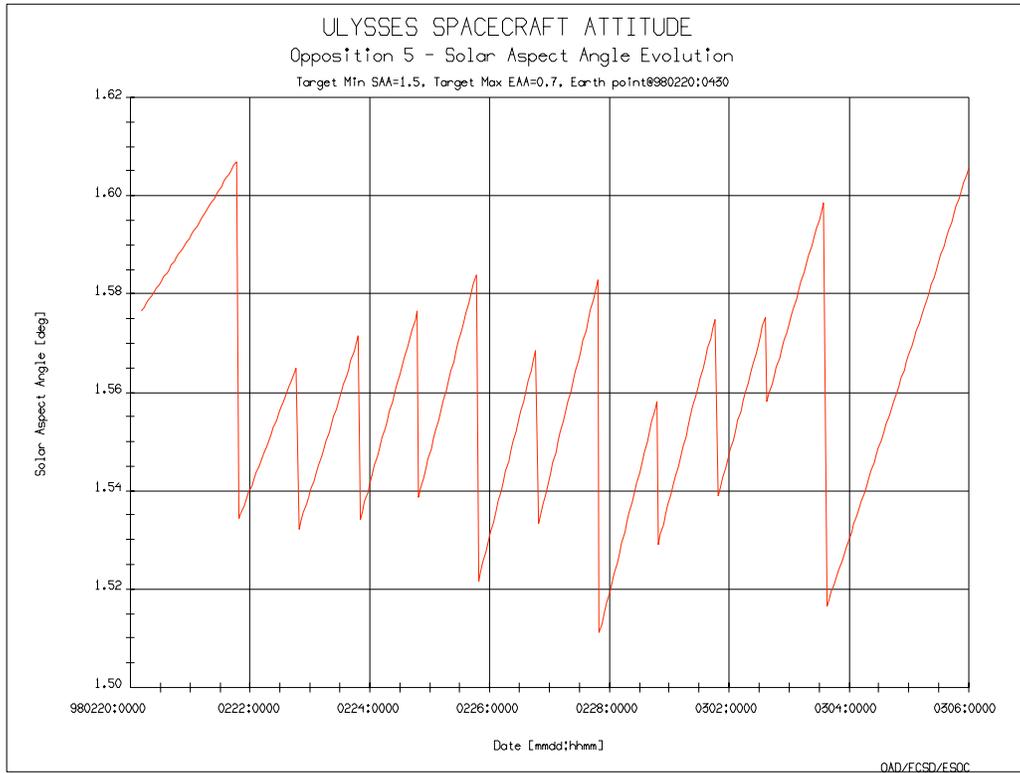


Figure 4: Actual SAA Evolution during Opposition 5

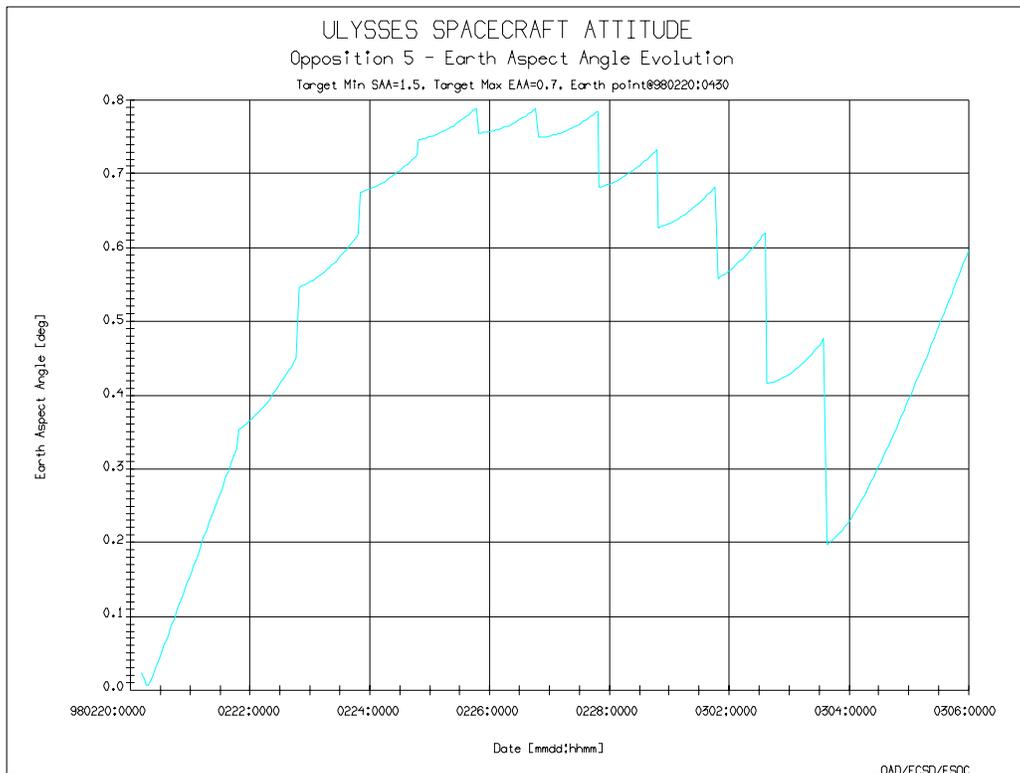


Figure 5: Actual EAA Evolution during Opposition 5

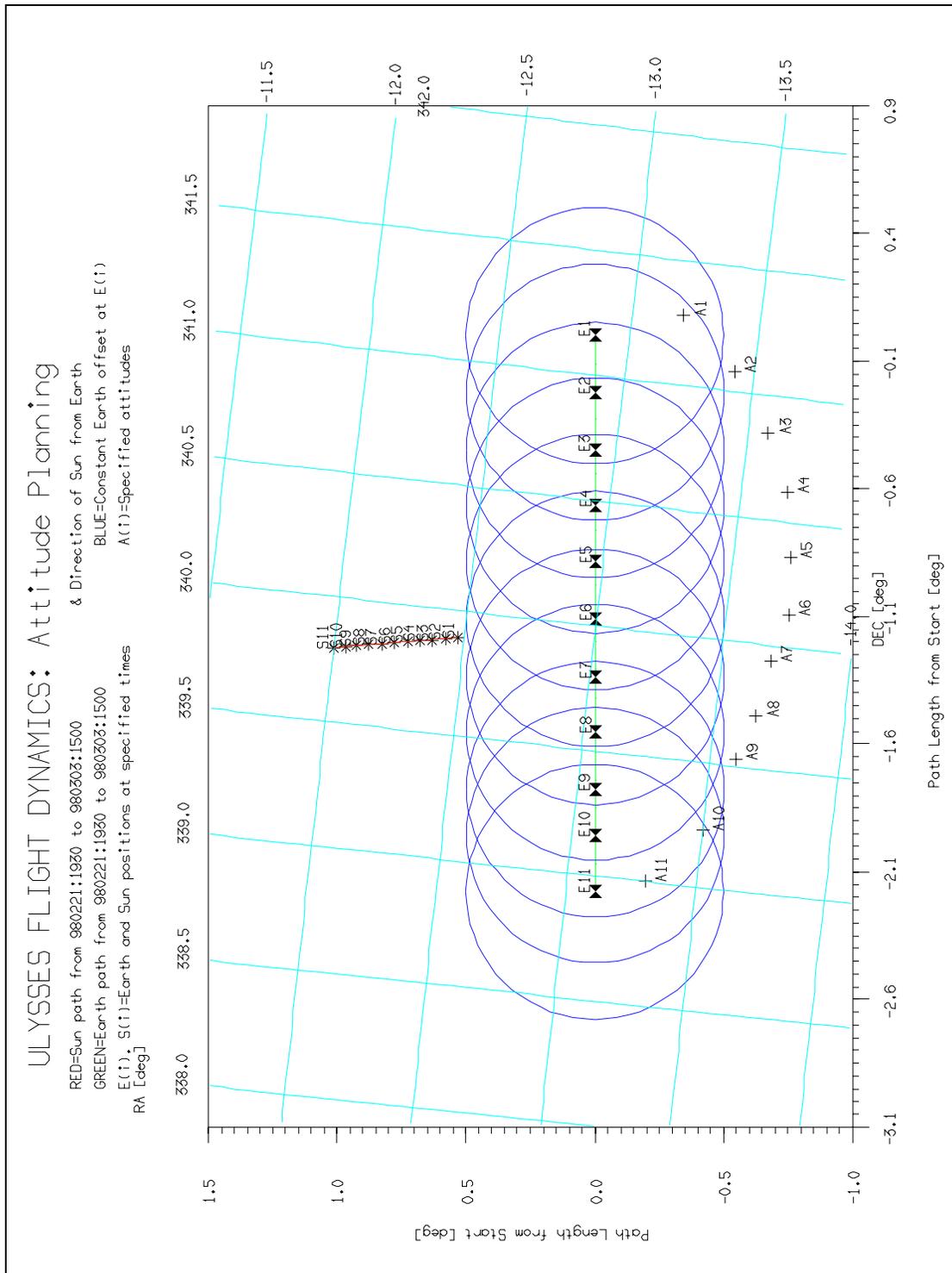


Figure 6: Earth and Sun Paths and Actual Attitudes for Opposition 5

Legend for Projection of Celestial Sphere Centred on Spacecraft

i = i th slew; A_i = spacecraft attitude after i th slew;
 E_i = Earth position at time of i th slew; S_i = Sun position at time of i th slew;
 cyan grid = right ascension and declination grid; blue circles = 0.7° EAA

3.4 Manoeuvre Evaluation

3.4.1 Attitude Determination

The pre- and post-manoeuvre attitudes were computed using data samples of the results from the real-time monitor's attitude determination process, *Results 2*, which are output to the alphanumeric display. See Figure 7 for a sample screen shot of the real-time monitor's alphanumeric display.

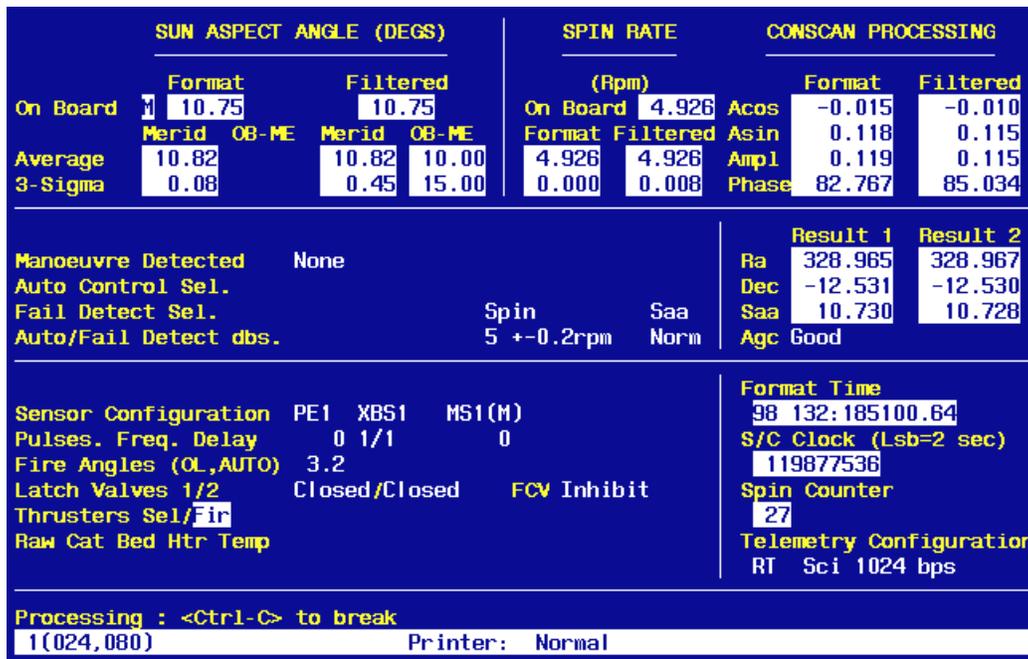


Figure 7: Screen Shot of Real-Time Monitor Alphanumeric Display

For each run a number of attitude data samples (typically 10 but more if data was noisy) were taken and fitted, using a least squares fit, using program *ATTFIT* to obtain a best estimate of the true attitude. Usually the pre-manoeuvre attitude samples were taken during a one hour period before the start of the manoeuvre. The post-manoeuvre attitude samples were taken after the post-manoeuvre nutation to died down sufficiently and this was usually over an hour after the manoeuvre has terminated.

3.4.2 Evaluation of Thruster Performance

The performance of the thruster used, LA1, for the manoeuvres was evaluated after each manoeuvre. Corrections to the in-flight thruster calibration data for the thruster and duty cycle used (LA1, 1 pulse per 2 spins, 3.2° pulse width) were made. The manoeuvres were resimulated using program *NR* as a cross-check (the end attitudes from the resimulations should be the same as the observed values given the same inputs) and to produce the manoeuvre description forms (see Appendix D).

Manoeuvre, FDS ID	Thruster Firing Parameters		Rhumb Angle		Rhumb Length		Thruster Calibration [LA1, 1 per 2, 3.2°]	
	Pulses	Phase Delay	Planned	Actual	Planned	Actual	Thrust Level	Centroid Delay
<i>Baseline</i>			–	–	–	–	1.155	9 ms
Slew 0, X868	16	797	14.144°	10.056°	0.320°	0.321°	1.158	-129 ms
Slew 1, X869	19	980	74.676°	79.200°	0.382°	0.380°	1.153	-10 ms
Slew 2, X870	14	979	77.851°	82.990°	0.279°	0.278°	1.151	+164 ms
Slew 3, X871	13	991	82.075°	83.910°	0.258°	0.269°	1.159	+61 ms
Slew 4, X872	11	975	76.443°	78.554°	0.218°	0.219°	1.005	+71 ms
Slew 5, X873	10	952	70.189°	73.072°	0.206°	0.213°	1.242	+150 ms
Slew 6, X874	10	966	75.123°	74.213°	0.206°	0.196°	1.140	+21 ms
Slew 7, X875	9	928	60.791°	60.607°	0.175°	0.183°	1.192	+15 ms
Slew 8, X876	12	977	78.058°	77.301°	0.235°	0.225°	1.079	-5 ms
Slew 9, X877	11	965	73.670°	72.700°	0.225°	0.190°	1.008	-18 ms
Slew 10, X878	15	994	83.251°	83.972°	0.280°	0.291°	1.119	+19 ms
Slew 11, X879	16	963	74.676°	79.200°	0.218°	0.219°	1.224	+84 ms

Table 3: Summary of Thruster Performance During Opposition 5

Appendix A **MPFs from Manoeuvre Preparation**

```
C*****
C NR COMMAND FILE FOR AN OPEN LOOP SLEW MANOEUVRE
C
C 18-FEB-1998, ckc
C Opposition 5 slew 0
C Slew to Earth pointing attitude on 980220:0430
C Initial attitude from attitude determination done for telemetry in the
C period 980218:1230 to 1400 (EAA < 0.05 deg)
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:02:18 20.24.49
=====

START TIME: 980220:043005.70
STOP TIME: 980220:043635.30

SPACE-CRAFT ATTITUDE IN MES1950

	AT START TIME	AT STOP TIME	
RIGHT ASCENSION	341.857	341.530	DEG
DECLINATION	-12.787	-12.821	DEG
SUN ASPECT ANGLE	1.915	1.604	DEG
EARTH ASPECT ANGLE	0.328	0.009	DEG
SPIN PERIOD	12.175	12.175	SEC

DELTA-V IMPARTED TO THE SPACECRAFT

X COMPONENT	0.004 M/S
Y COMPONENT	-0.001 M/S
Z COMPONENT	-0.001 M/S
ABSOLUTE VALUE	0.005 M/S
COMPONENT IN EARTH DIRECTION	-0.005 M/S

MASS PROPERTIES OF SPACECRAFT

	AT START TIME	AT STOP TIME	
MASS	344.070	344.069	KG
Z MOMENT OF INERTIA	534.980	534.980	KGMS

MANOEUVRE PARAMETERS

```
OPEN LOOP THRUSTERS      : 08 LA1
THRUSTER FREQUENCY      : 1/2
THRUSTER PULSE WIDTH    : 3.16 DEG
THRUSTER FIRING MODE    : PULSED ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 16
TELECOMMANDED PHASE DELAY : 797
```

SPACECRAFT PARAMETERS

	AT START TIME	AT STOP TIME	
TANK PRESSURE	7.523	7.523	BAR
FUEL LEFT	11.030	11.029	KG
FUEL RATE	0.0034	0.0034	G/S
AXIAL FORCE COMPONENT	0.0041	0.0041	NEWTON
AXIAL TORQUE COMPONENT	0.0000	0.0000	N METRE
RADIAL FORCE COMPONENT	0.0000	0.0000	NEWTON
AZIMUTH OF FORCE	-177.249	-177.249	DEG
RADIAL TORQUE COMPONENT	0.0040	0.0040	N METRE
AZIMUTH OF TORQUE	14.049	14.049	DEG

FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.155, AZI +0.00900 SEC
                               FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

RHUMB ANGLE 14.144 DEG PATH LENGTH 0.320 DEG

FDS FILE : X868.....

```
C*****
C NR COMMAND FILE FOR AN OPEN LOOP SLEW MANOEUVRE
C
C CKC, 20-FEB-1998
C Opp5 slew 1
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:02:20 20.51.28

START TIME: 980221:192951.45
 STOP TIME: 980221:193734.10

SPACE-CRAFT ATTITUDE IN MES1950

	AT START TIME	AT STOP TIME	
RIGHT ASCENSION	341.505	341.282	DEG
DECLINATION	-12.833	-13.147	DEG
SUN ASPECT ANGLE	1.613	1.512	DEG
EARTH ASPECT ANGLE	0.339	0.305	DEG
SPIN PERIOD	12.175	12.175	SEC

DELTA-V IMPARTED TO THE SPACECRAFT

X COMPONENT	0.005 M/S
Y COMPONENT	-0.002 M/S
Z COMPONENT	-0.001 M/S
ABSOLUTE VALUE	0.005 M/S
COMPONENT IN EARTH DIRECTION	-0.005 M/S

MASS PROPERTIES OF SPACECRAFT

	AT START TIME	AT STOP TIME	
MASS	344.069	344.067	KG
Z MOMENT OF INERTIA	534.980	534.980	KGMS

MANOEUVRE PARAMETERS

```
OPEN LOOP THRUSTERS      : 08 LA1
THRUSTER FREQUENCY      : 1/2
THRUSTER PULSE WIDTH    : 3.16 DEG
THRUSTER FIRING MODE    : PULSED ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 19
TELECOMMANDED PHASE DELAY : 980
```

SPACECRAFT PARAMETERS

	AT START TIME	AT STOP TIME	
TANK PRESSURE	7.523	7.523	BAR
FUEL LEFT	11.029	11.027	KG
FUEL RATE	0.0034	0.0034	G/S
AXIAL FORCE COMPONENT	0.0041	0.0041	NEWTON
AXIAL TORQUE COMPONENT	0.0000	0.0000	N METRE
RADIAL FORCE COMPONENT	0.0000	0.0000	NEWTON
AZIMUTH OF FORCE	-112.913	-112.913	DEG
RADIAL TORQUE COMPONENT	0.0040	0.0040	N METRE
AZIMUTH OF TORQUE	74.305	74.305	DEG

FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.158, AZI -0.12900 SEC
                               FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

RHUMB ANGLE 74.676 DEG PATH LENGTH 0.382 DEG

FDS FILE : X869.....

```
C*****
C NR COMMAND FILE FOR AN OPEN LOOP SLEW MANOEUVRE
C
C CKC, 21-FEB-1998
C Opp5 slew 2
C Target attitude for this manoeuvre = 341.08, -13.38
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:02:21 22.43.16
=====

START TIME: 980222:192952.53
STOP TIME: 980222:193533.37

SPACE-CRAFT ATTITUDE IN MES1950

	AT START TIME	AT STOP TIME	
RIGHT ASCENSION	341.280	341.073	DEG
DECLINATION	-13.195	-13.387	DEG
SUN ASPECT ANGLE	1.564	1.505	DEG
EARTH ASPECT ANGLE	0.453	0.512	DEG
SPIN PERIOD	12.173	12.173	SEC

DELTA-V IMPARTED TO THE SPACECRAFT

X COMPONENT	0.004 M/S
Y COMPONENT	-0.001 M/S
Z COMPONENT	-0.001 M/S
ABSOLUTE VALUE	0.004 M/S
COMPONENT IN EARTH DIRECTION	-0.004 M/S

MASS PROPERTIES OF SPACECRAFT

	AT START TIME	AT STOP TIME	
MASS	344.067	344.066	KG
Z MOMENT OF INERTIA	534.980	534.980	KGMS

MANOEUVRE PARAMETERS

```
OPEN LOOP THRUSTERS : 08 LA1
THRUSTER FREQUENCY : 1/2
THRUSTER PULSE WIDTH : 3.16 DEG
THRUSTER FIRING MODE : PULSED ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 14
TELECOMMANDED PHASE DELAY : 979
```

SPACECRAFT PARAMETERS

	AT START TIME	AT STOP TIME	
TANK PRESSURE	7.514	7.514	BAR
FUEL LEFT	11.027	11.026	KG
FUEL RATE	0.0034	0.0034	G/S
AXIAL FORCE COMPONENT	0.0040	0.0040	NEWTON
AXIAL TORQUE COMPONENT	0.0000	0.0000	N METRE
RADIAL FORCE COMPONENT	0.0000	0.0000	NEWTON
AZIMUTH OF FORCE	-113.264	-113.263	DEG
RADIAL TORQUE COMPONENT	0.0040	0.0040	N METRE
AZIMUTH OF TORQUE	77.473	77.473	DEG

FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.153, AZI -0.01000 SEC
FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

```
RHUMB ANGLE 77.851 DEG PATH LENGTH 0.279 DEG
FDS FILE : X870.....
```

```
C*****
C NR COMMAND FILE FOR AN OPEN LOOP SLEW MANOEUVRE
C
C CKC, 21-FEB-1998
C Opp5 slew 3, preliminary (based on data before execution of slew 2)
C Target attitude = 340.86, -13.54
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:02:21 23.24.18
=====

START TIME: 980223:195945.63
STOP TIME: 980223:200502.13

SPACE-CRAFT ATTITUDE IN MES1950

	AT START TIME	AT STOP TIME	
RIGHT ASCENSION	341.080	340.868	DEG
DECLINATION	-13.380	-13.535	DEG
SUN ASPECT ANGLE	1.546	1.510	DEG
EARTH ASPECT ANGLE	0.588	0.635	DEG
SPIN PERIOD	12.173	12.173	SEC

DELTA-V IMPARTED TO THE SPACECRAFT

X COMPONENT	0.003 M/S
Y COMPONENT	-0.001 M/S
Z COMPONENT	-0.001 M/S
ABSOLUTE VALUE	0.004 M/S
COMPONENT IN EARTH DIRECTION	-0.004 M/S

MASS PROPERTIES OF SPACECRAFT

	AT START TIME	AT STOP TIME	
MASS	344.066	344.065	KG
Z MOMENT OF INERTIA	534.980	534.980	KGMS

MANOEUVRE PARAMETERS

```
OPEN LOOP THRUSTERS : 08 LA1
THRUSTER FREQUENCY : 1/2
THRUSTER PULSE WIDTH : 3.16 DEG
THRUSTER FIRING MODE : PULSED ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 13
TELECOMMANDED PHASE DELAY : 991
```

SPACECRAFT PARAMETERS

	AT START TIME	AT STOP TIME	
TANK PRESSURE	7.514	7.514	BAR
FUEL LEFT	11.026	11.025	KG
FUEL RATE	0.0034	0.0034	G/S
AXIAL FORCE COMPONENT	0.0040	0.0040	NEWTON
AXIAL TORQUE COMPONENT	0.0000	0.0000	N METRE
RADIAL FORCE COMPONENT	0.0000	0.0000	NEWTON
AZIMUTH OF FORCE	-109.045	-109.045	DEG
RADIAL TORQUE COMPONENT	0.0040	0.0040	N METRE
AZIMUTH OF TORQUE	81.691	81.691	DEG

FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE

CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.153, AZI -0.01000 SEC
FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC

RHUMB ANGLE 82.075 DEG PATH LENGTH 0.258 DEG

FDS FILE : X871.....

```
C*****
C NR COMMAND FILE FOR AN OPEN LOOP SLEW MANOEUVRE
C
C CKC, 21-FEB-1998
C Opp5 slew 4, preliminary (based on data before execution of slew 2)
C Target attitude = 340.65, -13.62
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:02:21 23.28.06
=====

START TIME: 980224:192954.69
STOP TIME: 980224:193422.49

SPACE-CRAFT ATTITUDE IN MES1950

	AT START TIME	AT STOP TIME	
RIGHT ASCENSION	340.860	340.651	DEG
DECLINATION	-13.540	-13.619	DEG
SUN ASPECT ANGLE	1.552	1.501	DEG
EARTH ASPECT ANGLE	0.699	0.693	DEG
SPIN PERIOD	12.173	12.173	SEC

DELTA-V IMPARTED TO THE SPACECRAFT

X COMPONENT	0.003 M/S
Y COMPONENT	-0.001 M/S
Z COMPONENT	-0.001 M/S
ABSOLUTE VALUE	0.003 M/S
COMPONENT IN EARTH DIRECTION	-0.003 M/S

MASS PROPERTIES OF SPACECRAFT

	AT START TIME	AT STOP TIME	
MASS	344.065	344.064	KG
Z MOMENT OF INERTIA	534.980	534.980	KGMS

MANOEUVRE PARAMETERS

```
OPEN LOOP THRUSTERS : 08 LA1
THRUSTER FREQUENCY : 1/2
THRUSTER PULSE WIDTH : 3.16 DEG
THRUSTER FIRING MODE : PULSED ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 11
TELECOMMANDED PHASE DELAY : 975
```

SPACECRAFT PARAMETERS

	AT START TIME	AT STOP TIME	
TANK PRESSURE	7.514	7.514	BAR
FUEL LEFT	11.025	11.024	KG
FUEL RATE	0.0034	0.0034	G/S
AXIAL FORCE COMPONENT	0.0040	0.0040	NEWTON
AXIAL TORQUE COMPONENT	0.0000	0.0000	N METRE
RADIAL FORCE COMPONENT	0.0000	0.0000	NEWTON
AZIMUTH OF FORCE	-114.670	-114.670	DEG
RADIAL TORQUE COMPONENT	0.0040	0.0040	N METRE
AZIMUTH OF TORQUE	76.066	76.066	DEG

FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE

CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.153, AZI -0.01000 SEC
FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC

RHUMB ANGLE 76.443 DEG PATH LENGTH 0.218 DEG
FDS FILE : X872.....

```
C*****
C NR COMMAND FILE FOR AN OPEN LOOP SLEW MANOEUVRE
C
C CKC, 24-FEB-1998
C Opposition 5 slew 5
C - planned before execution of slew 4 using observations from slew 3
C Target attitude = 340.43, -13.68
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:02:24 01.08.58
=====

START TIME: 980225:192955.77
STOP TIME: 980225:193359.27

SPACE-CRAFT ATTITUDE IN MES1950

	AT START TIME	AT STOP TIME	
RIGHT ASCENSION	340.633	340.422	DEG
DECLINATION	-13.661	-13.681	DEG
SUN ASPECT ANGLE	1.575	1.506	DEG
EARTH ASPECT ANGLE	0.781	0.727	DEG
SPIN PERIOD	12.175	12.175	SEC

DELTA-V IMPARTED TO THE SPACECRAFT

X COMPONENT	0.003 M/S
Y COMPONENT	-0.001 M/S
Z COMPONENT	-0.001 M/S
ABSOLUTE VALUE	0.003 M/S
COMPONENT IN EARTH DIRECTION	-0.003 M/S

MASS PROPERTIES OF SPACECRAFT

	AT START TIME	AT STOP TIME	
MASS	344.065	344.064	KG
Z MOMENT OF INERTIA	534.980	534.980	KGMS

MANOEUVRE PARAMETERS

```
OPEN LOOP THRUSTERS      : 08 LA1
THRUSTER FREQUENCY      : 1/2
THRUSTER PULSE WIDTH    : 3.16 DEG
THRUSTER FIRING MODE    : PULSED ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 10
TELECOMMANDED PHASE DELAY : 952
```

SPACECRAFT PARAMETERS

	AT START TIME	AT STOP TIME	
TANK PRESSURE	7.514	7.514	BAR
FUEL LEFT	11.025	11.024	KG
FUEL RATE	0.0034	0.0034	G/S
AXIAL FORCE COMPONENT	0.0040	0.0040	NEWTON
AXIAL TORQUE COMPONENT	0.0000	0.0000	N METRE
RADIAL FORCE COMPONENT	0.0000	0.0000	NEWTON
AZIMUTH OF FORCE	-122.756	-122.756	DEG
RADIAL TORQUE COMPONENT	0.0042	0.0042	N METRE
AZIMUTH OF TORQUE	69.814	69.814	DEG

FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.201, AZI +0.05200 SEC
                           FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

```
RHUMB ANGLE 70.189 DEG PATH LENGTH 0.206 DEG
FDS FILE : X873.....
```

```
C*****
C NR COMMAND FILE FOR AN OPEN LOOP SLEW MANOEUVRE
C
C CKC, 24-FEB-1998
C Opposition 5 slew 6
C - planned before execution of slew 4 using observations from slew 3 and
C simulation of slew 5
C Target attitude = 340.20, -13.69
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:02:24 01.13.22
=====

START TIME: 980226:192956.85
STOP TIME: 980226:193400.35

SPACE-CRAFT ATTITUDE IN MES1950

	AT START TIME	AT STOP TIME	
RIGHT ASCENSION	340.422	340.211	DEG
DECLINATION	-13.681	-13.691	DEG
SUN ASPECT ANGLE	1.554	1.502	DEG
EARTH ASPECT ANGLE	0.783	0.716	DEG
SPIN PERIOD	12.175	12.175	SEC

DELTA-V IMPARTED TO THE SPACECRAFT

X COMPONENT	0.003 M/S
Y COMPONENT	-0.001 M/S
Z COMPONENT	-0.001 M/S
ABSOLUTE VALUE	0.003 M/S
COMPONENT IN EARTH DIRECTION	-0.003 M/S

MASS PROPERTIES OF SPACECRAFT

	AT START TIME	AT STOP TIME	
MASS	344.064	344.063	KG
Z MOMENT OF INERTIA	534.980	534.980	KGMS

MANOEUVRE PARAMETERS

```
OPEN LOOP THRUSTERS : 08 LA1
THRUSTER FREQUENCY : 1/2
THRUSTER PULSE WIDTH : 3.16 DEG
THRUSTER FIRING MODE : PULSED ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 10
TELECOMMANDED PHASE DELAY : 966
```

SPACECRAFT PARAMETERS

	AT START TIME	AT STOP TIME	
TANK PRESSURE	7.514	7.514	BAR
FUEL LEFT	11.024	11.023	KG
FUEL RATE	0.0034	0.0034	G/S
AXIAL FORCE COMPONENT	0.0040	0.0040	NEWTON
AXIAL TORQUE COMPONENT	0.0000	0.0000	N METRE
RADIAL FORCE COMPONENT	0.0000	0.0000	NEWTON
AZIMUTH OF FORCE	-117.834	-117.834	DEG
RADIAL TORQUE COMPONENT	0.0042	0.0042	N METRE
AZIMUTH OF TORQUE	74.735	74.735	DEG

FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.201, AZI +0.05200 SEC
FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

```
RHUMB ANGLE 75.123 DEG PATH LENGTH 0.206 DEG
FDS FILE : X874.....
```

```
C*****
C NR COMMAND FILE FOR AN OPEN LOOP SLEW MANOEUVRE
C
C CKC, 26-FEB-1998
C Opposition 5 slew 7
C - planned using observations from end of slew 6
C Target attitude = 339.97, -13.68
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:02:26 23.02.35

```
START TIME: 980227:195949.95
STOP TIME: 980227:200329.10
```

SPACE-CRAFT ATTITUDE IN MES1950

```
-----
                AT START TIME          AT STOP TIME
RIGHT ASCENSION      340.131          339.963    DEG
DECLINATION          -13.741          -13.677    DEG
SUN ASPECT ANGLE     1.585            1.500    DEG
EARTH ASPECT ANGLE   0.788            0.674    DEG
SPIN PERIOD          12.175           12.175    SEC
```

DELTA-V IMPARTED TO THE SPACECRAFT

```
-----
X COMPONENT           0.002 M/S
Y COMPONENT          -0.001 M/S
Z COMPONENT          -0.001 M/S
ABSOLUTE VALUE        0.002 M/S
COMPONENT IN EARTH DIRECTION -0.002 M/S
```

MASS PROPERTIES OF SPACECRAFT

```
-----
                AT START TIME          AT STOP TIME
MASS                 344.062          344.061    KG
Z MOMENT OF INERTIA  534.980          534.980   KGMS
```

MANOEUVRE PARAMETERS

```
-----
OPEN LOOP THRUSTERS      : 08 LA1
THRUSTER FREQUENCY       : 1/2
THRUSTER PULSE WIDTH    : 3.16 DEG
THRUSTER FIRING MODE    : PULSED ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 9
TELECOMMANDED PHASE DELAY : 928
```

SPACECRAFT PARAMETERS

```
-----
                AT START TIME          AT STOP TIME
TANK PRESSURE         7.513            7.513    BAR
FUEL LEFT             11.022           11.021    KG
FUEL RATE             0.0034           0.0034   G/S
AXIAL FORCE COMPONENT  0.0040           0.0040   NEWTON
AXIAL TORQUE COMPONENT 0.0000           0.0000   N METRE
RADIAL FORCE COMPONENT 0.0000           0.0000   NEWTON
AZIMUTH OF FORCE       -131.193         -131.193  DEG
RADIAL TORQUE COMPONENT 0.0040           0.0040   N METRE
AZIMUTH OF TORQUE     60.459           60.459   DEG
FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE
```

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.140, AZI +0.02100 SEC
                              FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

```
RHUMB ANGLE 60.791 DEG  PATH LENGTH 0.175 DEG
FDS FILE : X875.....
```

```
C*****
C NR COMMAND FILE FOR AN OPEN LOOP SLEW MANOEUVRE
C
C CKC, 27-FEB-1998
C Opposition 5 slew 8
C - planned using observations from end of slew 6 and simulation of slew 7
C Target attitude = 339.72, -13.63
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:02:27 02.27.19
=====

START TIME: 980228:192959.01
STOP TIME: 980228:193451.21

SPACE-CRAFT ATTITUDE IN MES1950

	AT START TIME	AT STOP TIME	
RIGHT ASCENSION	339.963	339.726	DEG
DECLINATION	-13.677	-13.631	DEG
SUN ASPECT ANGLE	1.548	1.499	DEG
EARTH ASPECT ANGLE	0.735	0.603	DEG
SPIN PERIOD	12.175	12.175	SEC

DELTA-V IMPARTED TO THE SPACECRAFT

X COMPONENT	0.003 M/S
Y COMPONENT	-0.001 M/S
Z COMPONENT	-0.001 M/S
ABSOLUTE VALUE	0.003 M/S
COMPONENT IN EARTH DIRECTION	-0.003 M/S

MASS PROPERTIES OF SPACECRAFT

	AT START TIME	AT STOP TIME	
MASS	344.061	344.060	KG
Z MOMENT OF INERTIA	534.980	534.980	KGMS

MANOEUVRE PARAMETERS

```
OPEN LOOP THRUSTERS      : 08 LA1
THRUSTER FREQUENCY      : 1/2
THRUSTER PULSE WIDTH    : 3.16 DEG
THRUSTER FIRING MODE    : PULSED ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 12
TELECOMMANDED PHASE DELAY : 977
```

SPACECRAFT PARAMETERS

	AT START TIME	AT STOP TIME	
TANK PRESSURE	7.513	7.513	BAR
FUEL LEFT	11.021	11.020	KG
FUEL RATE	0.0034	0.0034	G/S
AXIAL FORCE COMPONENT	0.0040	0.0040	NEWTON
AXIAL TORQUE COMPONENT	0.0000	0.0000	N METRE
RADIAL FORCE COMPONENT	0.0000	0.0000	NEWTON
AZIMUTH OF FORCE	-113.967	-113.967	DEG
RADIAL TORQUE COMPONENT	0.0040	0.0040	N METRE
AZIMUTH OF TORQUE	77.686	77.686	DEG

FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.140, AZI +0.02100 SEC
                           FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

```
RHUMB ANGLE 78.058 DEG PATH LENGTH 0.235 DEG
FDS FILE : X876.....
```

```
C*****
C NR COMMAND FILE FOR AN OPEN LOOP SLEW MANOEUVRE
C
C CKC, 28-FEB-1998
C Opposition 5 slew 9
C - planned using observations from end of slew 7 and simulation of slew 8
C Target attitude = 339.49, -13.55
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:02:28 01.12.58

```
START TIME: 980301:193000.09
STOP TIME: 980301:193427.94
```

SPACE-CRAFT ATTITUDE IN MES1950

```
-----
                AT START TIME          AT STOP TIME
RIGHT ASCENSION      339.693            339.483    DEG
DECLINATION          -13.641            -13.547    DEG
SUN ASPECT ANGLE     1.559              1.496     DEG
EARTH ASPECT ANGLE   0.662              0.494     DEG
SPIN PERIOD          12.175             12.175    SEC
```

DELTA-V IMPARTED TO THE SPACECRAFT

```
-----
X COMPONENT           0.003 M/S
Y COMPONENT          -0.001 M/S
Z COMPONENT          -0.001 M/S
ABSOLUTE VALUE        0.003 M/S
COMPONENT IN EARTH DIRECTION -0.003 M/S
```

MASS PROPERTIES OF SPACECRAFT

```
-----
                AT START TIME          AT STOP TIME
MASS                 344.060            344.059    KG
Z MOMENT OF INERTIA  534.980            534.980   KGMS
```

MANOEUVRE PARAMETERS

```
-----
OPEN LOOP THRUSTERS      : 08 LA1
THRUSTER FREQUENCY      : 1/2
THRUSTER PULSE WIDTH    : 3.16 DEG
THRUSTER FIRING MODE    : PULSED ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 11
TELECOMMANDED PHASE DELAY : 965
```

SPACECRAFT PARAMETERS

```
-----
                AT START TIME          AT STOP TIME
TANK PRESSURE         7.513              7.513     BAR
FUEL LEFT              11.020             11.019    KG
FUEL RATE              0.0034             0.0034    G/S
AXIAL FORCE COMPONENT   0.0040             0.0040    NEWTON
AXIAL TORQUE COMPONENT 0.0000             0.0000    N METRE
RADIAL FORCE COMPONENT  0.0000             0.0000    NEWTON
AZIMUTH OF FORCE        -118.186            -118.186  DEG
RADIAL TORQUE COMPONENT 0.0042             0.0042    N METRE
AZIMUTH OF TORQUE      73.290             73.290    DEG
FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE
```

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.192, AZI +0.01500 SEC
                               FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

```
RHUMB ANGLE 73.670 DEG PATH LENGTH 0.225 DEG
FDS FILE : X877.....
```

```
C*****
C NR COMMAND FILE FOR SIMULATING PULSED FIRING OR RHUMB LINE SLEW MANOEUVRES
C
C CKC, 28-FEB-1998
C Simulation of Opposition 5 slew 10
C - planned using observations from end of slew 8 and simulation of slew 9
C Target attitude = 339.25, -13.44
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:03:01 00.35.49
=====

START TIME: 980302:150008.96
STOP TIME: 980302:150614.21

SPACE-CRAFT ATTITUDE IN MES1950

	AT START TIME	AT STOP TIME	
RIGHT ASCENSION	339.515	339.250	DEG
DECLINATION	-13.548	-13.440	DEG
SUN ASPECT ANGLE	1.528	1.495	DEG
EARTH ASPECT ANGLE	0.572	0.360	DEG
SPIN PERIOD	12.175	12.175	SEC

DELTA-V IMPARTED TO THE SPACECRAFT

X COMPONENT	0.004 M/S
Y COMPONENT	-0.001 M/S
Z COMPONENT	-0.001 M/S
ABSOLUTE VALUE	0.004 M/S
COMPONENT IN EARTH DIRECTION	-0.004 M/S

MASS PROPERTIES OF SPACECRAFT

	AT START TIME	AT STOP TIME	
MASS	344.059	344.058	KG
Z MOMENT OF INERTIA	534.980	534.980	KGMS

MANOEUVRE PARAMETERS

```
OPEN LOOP THRUSTERS      : 08 LA1
THRUSTER FREQUENCY      : 1/2
THRUSTER PULSE WIDTH    : 3.16 DEG
THRUSTER FIRING MODE    : PULSED ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 15
TELECOMMANDED PHASE DELAY : 994
```

SPACECRAFT PARAMETERS

	AT START TIME	AT STOP TIME	
TANK PRESSURE	7.513	7.512	BAR
FUEL LEFT	11.019	11.018	KG
FUEL RATE	0.0034	0.0034	G/S
AXIAL FORCE COMPONENT	0.0040	0.0040	NEWTON
AXIAL TORQUE COMPONENT	0.0000	0.0000	N METRE
RADIAL FORCE COMPONENT	0.0000	0.0000	NEWTON
AZIMUTH OF FORCE	-107.990	-107.990	DEG
RADIAL TORQUE COMPONENT	0.0038	0.0038	N METRE
AZIMUTH OF TORQUE	82.894	82.894	DEG

FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.079, AZI -0.00500 SEC
                           FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

```
RHUMB ANGLE 83.251 DEG PATH LENGTH 0.280 DEG
FDS FILE : X878.....
```

```
C*****
C NR COMMAND FILE FOR SIMULATING PULSED FIRING OR RHUMB LINE SLEW MANOEUVRES
C
C CKC, 28-FEB-1998
C Opposition 5 slew 11
C - planned using observations from end of slew 10
C Target attitude = 339.00, -13.29
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:03:02 21.11.51
=====

START TIME: 980303:150010.04
STOP TIME: 980303:150639.64

SPACE-CRAFT ATTITUDE IN MES1950

	AT START TIME	AT STOP TIME	
RIGHT ASCENSION	339.233	338.999	DEG
DECLINATION	-13.499	-13.290	DEG
SUN ASPECT ANGLE	1.598	1.508	DEG
EARTH ASPECT ANGLE	0.481	0.187	DEG
SPIN PERIOD	12.175	12.175	SEC

DELTA-V IMPARTED TO THE SPACECRAFT

X COMPONENT	0.004 M/S
Y COMPONENT	-0.002 M/S
Z COMPONENT	-0.001 M/S
ABSOLUTE VALUE	0.005 M/S
COMPONENT IN EARTH DIRECTION	-0.005 M/S

MASS PROPERTIES OF SPACECRAFT

	AT START TIME	AT STOP TIME	
MASS	344.058	344.057	KG
Z MOMENT OF INERTIA	534.980	534.980	KGMS

MANOEUVRE PARAMETERS

```
OPEN LOOP THRUSTERS      : 08 LA1
THRUSTER FREQUENCY      : 1/2
THRUSTER PULSE WIDTH    : 3.16 DEG
THRUSTER FIRING MODE    : PULSED ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 16
TELECOMMANDED PHASE DELAY : 963
```

SPACECRAFT PARAMETERS

	AT START TIME	AT STOP TIME	
TANK PRESSURE	7.512	7.512	BAR
FUEL LEFT	11.018	11.017	KG
FUEL RATE	0.0034	0.0034	G/S
AXIAL FORCE COMPONENT	0.0040	0.0040	NEWTON
AXIAL TORQUE COMPONENT	0.0000	0.0000	N METRE
RADIAL FORCE COMPONENT	0.0000	0.0000	NEWTON
AZIMUTH OF FORCE	-118.889	-118.889	DEG
RADIAL TORQUE COMPONENT	0.0039	0.0039	N METRE
AZIMUTH OF TORQUE	72.705	72.705	DEG

FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.119, AZI +0.01900 SEC
                           FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

```
RHUMB ANGLE 73.051 DEG PATH LENGTH 0.310 DEG
FDS FILE : X879.....
```

Appendix B Manoeuvre Telecommands

B.1 Slew 0

```

X868 PREC051:00:00:00                                21
051:00:00:00.0  BLKSTART      868
                  *TAGGED F5,94          980220:024045.61
                  @Z194                  CE ON
                  *TAGGED F5,95          980220:024117.61
                  -Z213 8486            TC1
                  -Z214 1010            SET NO. PULSES
                  -Z215 131D            FIRE ANGLE&PHASE
                  -Z216 0808            SELECT THRUSTER
                  @Z217 8648            SET SAA DB
                  *TAGGED F6,61          980220:043005.70
                  @Z216 0008            CB HEATERS OFF
                  *TAGGED F6,62          980220:043037.70
                  -Z201                  LV ON
                  @Z211                  EXECUTE MAN
                  *TAGGED F6,78          980220:044221.70
                  -Z212                  DISABLE MAN
                  @Z216 0000            DESELECT THR
                  *TAGGED F6,B4          980220:051421.73
                  @Z196                  CE OFF
                  BLKEND
    
```

```

Analysis of FDS file FDS$Dir:X868.DAT
=====
Line 1:X868 PREC051:00:00:00                                21
Line 2:051:00:00:00.0  BLKSTART      868
Line 3:                  *TAGGED F5,94          98 051:024045.61
Line 4:                  @Z194                  CE-1 ON
Line 5:                  *TAGGED F5,95          98 051:024117.61
Line 6:                  -Z213 8486            AOCE MODE-1
Line 7:                  -Z214 1010            TP NO+MODE-1
Line 8:                  -Z215 131D            TP DEL+WID-1
Line 9:                  -Z216 0808            THR+CB SEL-1
Line 10:                 @Z217 8648            SAA DB-1
      TC1: Receiver unit      : 2
          SAA msb             : 1
          SAA det. slit       : MS ONLY
          Conscan control     : OFF
          Constant SAA slew   : OFF
          SAA control         : OFF
          SPIN control        : OFF
          Conscan fail detect : OFF
          SAA fail detect     : ON
          SPIN fail detect    : ON D/B= 5+/-0.2 RPM
      TC2: THRUST fail detect : OFF
          Firing mode         : PULSED
          Firing frequency    : 1/2 SPIN
          Number of pulses    : 16
      TC3: O/L Thruster dir.   : AXIAL
          O/L Firing angle    : 3.2 deg
          O/L Firing phase    : 280.20 deg
          Pulses /Firing spin : 1
          D-V failure mode 2  : NORMAL
      TC4: CAT BED heaters     : LA1/LA2
          Thruster selection  : LA1
      TC5: with XBS1 Lower D/B= 1.312 Upper D/B= 2.393 deg
          with XBS2 Lower D/B= 1.278 Upper D/B= 2.330 deg
Line 11:                 *TAGGED F6,61          98 051:043005.70
Line 12:                 @Z216 0008            THR+CB SEL-1
      TC1: Receiver unit      : 2
          SAA msb             : 1
          SAA det. slit       : MS ONLY
          Conscan control     : OFF
    
```

```

Constant SAA slew : OFF
SAA control : OFF
SPIN control : OFF
Conscan fail detect : OFF
SAA fail detect : ON
SPIN fail detect : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode : PULSED
Firing frequency : 1/2 SPIN
Number of pulses : 16
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle : 3.2 deg
O/L Firing phase : 280.20 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : LA1
TC5: with XBS1 Lower D/B= 1.312 Upper D/B= 2.393 deg
with XBS2 Lower D/B= 1.278 Upper D/B= 2.330 deg
Line 13: *TAGGED F6,62 98 051:043037.70
Line 14: -Z201 LV1 ON-1
Line 15: @Z211 EXEC MAN-1
Line 16: *TAGGED F6,78 98 051:044221.70
Line 17: -Z212 DISA MAN-1
Line 18: @Z216 0000 THR+CB SEL-1
TC1: Receiver unit : 2
SAA msb : 1
SAA det. slit : MS ONLY
Conscan control : OFF
Constant SAA slew : OFF
SAA control : OFF
SPIN control : OFF
Conscan fail detect : OFF
SAA fail detect : ON
SPIN fail detect : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode : PULSED
Firing frequency : 1/2 SPIN
Number of pulses : 16
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle : 3.2 deg
O/L Firing phase : 280.20 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : NONE
TC5: with XBS1 Lower D/B= 1.312 Upper D/B= 2.393 deg
with XBS2 Lower D/B= 1.278 Upper D/B= 2.330 deg
Line 19: *TAGGED F6,B4 98 051:051421.73
Line 20: @Z196 CE1/2 OFF
Line 21: BLKEND
    
```

B.2 Slew 1

```

X869 PREC052:00:00:00                                21
052:00:00:00.0  BLKSTART      869
                  *TAGGED 06,B7          980221:174031.37
                  @Z194                  CE ON
                  *TAGGED 06,B8          980221:174103.37
                  -Z213 8486             TC1
                  -Z214 1013             SET NO. PULSES
                  -Z215 13D4             FIRE ANGLE&PHASE
                  -Z216 0808             SELECT THRUSTER
                  @Z217 8757             SET SAA DB
                  *TAGGED 07,84          980221:192951.45
                  @Z216 0008             CB HEATERS OFF
                  *TAGGED 07,85          980221:193023.45
                  -Z201                   LV ON
                  @Z211                   EXECUTE MAN
                  *TAGGED 07,9D          980221:194311.46
                  -Z212                   DISABLE MAN
                  @Z216 0000             DESELECT THR
                  *TAGGED 07,D9          980221:201511.48
                  @Z196                   CE OFF
                  BLKEND
    
```

```

Analysis of FDS file FDS$Dir:X869.DAT
=====
Line 1:X869 PREC052:00:00:00                                21
Line 2:052:00:00:00.0  BLKSTART      869
Line 3:                  *TAGGED 06,B7          98 052:174031.37
Line 4:                  @Z194                  CE-1 ON
Line 5:                  *TAGGED 06,B8          98 052:174103.37
Line 6:                  -Z213 8486             AOCE MODE-1
Line 7:                  -Z214 1013             TP NO+MODE-1
Line 8:                  -Z215 13D4             TP DEL+WID-1
Line 9:                  -Z216 0808             THR+CB SEL-1
Line 10:                 @Z217 8757             SAA DB-1
      TC1: Receiver unit      : 2
          SAA msb             : 1
          SAA det. slit       : MS ONLY
          Conscan control     : OFF
          Constant SAA slew   : OFF
          SAA control         : OFF
          SPIN control        : OFF
          Conscan fail detect : OFF
          SAA fail detect     : ON
          SPIN fail detect    : ON D/B= 5+/-0.2 RPM
      TC2: THRUST fail detect : OFF
          Firing mode         : PULSED
          Firing frequency    : 1/2 SPIN
          Number of pulses    : 19
      TC3: O/L Thruster dir.   : AXIAL
          O/L Firing angle    : 3.2 deg
          O/L Firing phase    : 344.53 deg
          Pulses /Firing spin : 1
          D-V failure mode 2  : NORMAL
      TC4: CAT BED heaters     : LA1/LA2
          Thruster selection  : LA1
      TC5: with XBS1 Lower D/B= 1.303 Upper D/B= 1.988 deg
          with XBS2 Lower D/B= 1.269 Upper D/B= 1.936 deg
Line 11:                 *TAGGED 07,84          98 052:192951.45
Line 12:                 @Z216 0008             THR+CB SEL-1
      TC1: Receiver unit      : 2
          SAA msb             : 1
          SAA det. slit       : MS ONLY
          Conscan control     : OFF
          Constant SAA slew   : OFF
    
```

```

SAA control      : OFF
SPIN control     : OFF
Conscan fail detect : OFF
SAA fail detect  : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode      : PULSED
Firing frequency : 1/2 SPIN
Number of pulses : 19
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle : 3.2 deg
O/L Firing phase : 344.53 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : LA1
TC5: with XBS1 Lower D/B= 1.303 Upper D/B= 1.988 deg
with XBS2 Lower D/B= 1.269 Upper D/B= 1.936 deg
Line 13:          *TAGGED 07,85 98 052:193023.45
Line 14:          -Z201 LV1 ON-1
Line 15:          @Z211 EXEC MAN-1
Line 16:          *TAGGED 07,9D 98 052:194311.46
Line 17:          -Z212 DISA MAN-1
Line 18:          @Z216 0000 THR+CB SEL-1
TC1: Receiver unit : 2
SAA msb            : 1
SAA det. slit     : MS ONLY
Conscan control   : OFF
Constant SAA slew : OFF
SAA control       : OFF
SPIN control      : OFF
Conscan fail detect : OFF
SAA fail detect   : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode       : PULSED
Firing frequency  : 1/2 SPIN
Number of pulses  : 19
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle  : 3.2 deg
O/L Firing phase  : 344.53 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : NONE
TC5: with XBS1 Lower D/B= 1.303 Upper D/B= 1.988 deg
with XBS2 Lower D/B= 1.269 Upper D/B= 1.936 deg
Line 19:          *TAGGED 07,D9 98 052:201511.48
Line 20:          @Z196 CE1/2 OFF
Line 21:          BLKEND
    
```

B.3 Slew 2

```

X870 PREC053:00:00:00                                21
053:00:00:00.0  BLKSTART      870
                  *TAGGED 11,43      980222:174032.45
                  @Z194              CE ON
                  *TAGGED 11,44      980222:174104.45
                  -Z213 8486        TC1
                  -Z214 100E        SET NO. PULSES
                  -Z215 13D3        FIRE ANGLE&PHASE
                  -Z216 0808        SELECT THRUSTER
                  @Z217 885A        SET SAA DB
                  *TAGGED 12,10      980222:192952.53
                  @Z216 0008        CB HEATERS OFF
                  *TAGGED 12,11      980222:193024.53
                  -Z201              LV ON
                  @Z211              EXECUTE MAN
                  *TAGGED 12,25      980222:194104.54
                  -Z212              DISABLE MAN
                  @Z216 0000        DESELECT THR
                  *TAGGED 12,61      980222:201304.56
                  @Z196              CE OFF
                  BLKEND
    
```

```

Analysis of FDS file FDS$Dir:X870.DAT
=====
Line 1:X870 PREC053:00:00:00                                21
Line 2:053:00:00:00.0  BLKSTART      870
Line 3:                  *TAGGED 11,43      98 053:174032.45
Line 4:                  @Z194              CE-1 ON
Line 5:                  *TAGGED 11,44      98 053:174104.45
Line 6:                  -Z213 8486        AOCE MODE-1
Line 7:                  -Z214 100E        TP NO+MODE-1
Line 8:                  -Z215 13D3        TP DEL+WID-1
Line 9:                  -Z216 0808        THR+CB SEL-1
Line 10:                 @Z217 885A        SAA DB-1

TC1: Receiver unit      : 2
    SAA msb              : 1
    SAA det. slit       : MS ONLY
    Conscan control     : OFF
    Constant SAA slew   : OFF
    SAA control         : OFF
    SPIN control        : OFF
    Conscan fail detect : OFF
    SAA fail detect     : ON
    SPIN fail detect    : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
    Firing mode         : PULSED
    Firing frequency    : 1/2 SPIN
    Number of pulses    : 14
TC3: O/L Thruster dir.  : AXIAL
    O/L Firing angle    : 3.2 deg
    O/L Firing phase    : 344.18 deg
    Pulses /Firing spin : 1
    D-V failure mode 2  : NORMAL
TC4: CAT BED heaters   : LA1/LA2
    Thruster selection  : LA1
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.923 deg
    with XBS2 Lower D/B= 1.260 Upper D/B= 1.873 deg
Line 11:                 *TAGGED 12,10      98 053:192952.53
Line 12:                 @Z216 0008        THR+CB SEL-1

TC1: Receiver unit      : 2
    SAA msb              : 1
    SAA det. slit       : MS ONLY
    Conscan control     : OFF
    Constant SAA slew   : OFF
    
```

```

SAA control      : OFF
SPIN control     : OFF
Conscan fail detect : OFF
SAA fail detect  : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode      : PULSED
Firing frequency : 1/2 SPIN
Number of pulses : 14
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle : 3.2 deg
O/L Firing phase : 344.18 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : LA1
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.923 deg
with XBS2 Lower D/B= 1.260 Upper D/B= 1.873 deg
Line 13:          *TAGGED 12,11 98 053:193024.53
Line 14:          -Z201 LV1 ON-1
Line 15:          @Z211 EXEC MAN-1
Line 16:          *TAGGED 12,25 98 053:194104.54
Line 17:          -Z212 DISA MAN-1
Line 18:          @Z216 0000 THR+CB SEL-1
TC1: Receiver unit : 2
SAA msb            : 1
SAA det. slit     : MS ONLY
Conscan control   : OFF
Constant SAA slew : OFF
SAA control       : OFF
SPIN control      : OFF
Conscan fail detect : OFF
SAA fail detect   : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode       : PULSED
Firing frequency  : 1/2 SPIN
Number of pulses  : 14
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle  : 3.2 deg
O/L Firing phase  : 344.18 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : NONE
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.923 deg
with XBS2 Lower D/B= 1.260 Upper D/B= 1.873 deg
Line 19:          *TAGGED 12,61 98 053:201304.56
Line 20:          @Z196 CE1/2 OFF
Line 21:          BLKEND
    
```

B.4 Slew 3

```

X871 PREC054:00:00:00                                21
054:00:00:00.0  BLKSTART      871
                  *TAGGED 1C,07          980223:181025.55
                  @Z194                  CE ON
                  *TAGGED 1C,08          980223:181057.55
                  -Z213 8486             TC1
                  -Z214 100D             SET NO. PULSES
                  -Z215 13DF             FIRE ANGLE&PHASE
                  -Z216 0808             SELECT THRUSTER
                  @Z217 885A             SET SAA DB
                  *TAGGED 1C,D4          980223:195945.63
                  @Z216 0008             CB HEATERS OFF
                  *TAGGED 1C,D5          980223:200017.63
                  -Z201                  LV ON
                  @Z211                  EXECUTE MAN
                  *TAGGED 1C,E8          980223:201025.64
                  -Z212                  DISABLE MAN
                  @Z216 0000             DESELECT THR
                  *TAGGED 1D,24          980223:204225.66
                  @Z196                  CE OFF
                  BLKEND
    
```

```

Analysis of FDS file FDS$Dir:X871.DAT
=====
Line 1:X871 PREC054:00:00:00                                21
Line 2:054:00:00:00.0  BLKSTART      871
Line 3:                  *TAGGED 1C,07          98 054:181025.55
Line 4:                  @Z194                  CE-1 ON
Line 5:                  *TAGGED 1C,08          98 054:181057.55
Line 6:                  -Z213 8486             AOCE MODE-1
Line 7:                  -Z214 100D             TP NO+MODE-1
Line 8:                  -Z215 13DF             TP DEL+WID-1
Line 9:                  -Z216 0808             THR+CB SEL-1
Line 10:                 @Z217 885A             SAA DB-1

TC1: Receiver unit      : 2
    SAA msb              : 1
    SAA det. slit       : MS ONLY
    Conscan control     : OFF
    Constant SAA slew   : OFF
    SAA control         : OFF
    SPIN control        : OFF
    Conscan fail detect : OFF
    SAA fail detect     : ON
    SPIN fail detect    : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
    Firing mode          : PULSED
    Firing frequency     : 1/2 SPIN
    Number of pulses     : 13
TC3: O/L Thruster dir.  : AXIAL
    O/L Firing angle     : 3.2 deg
    O/L Firing phase     : 348.40 deg
    Pulses /Firing spin : 1
    D-V failure mode 2   : NORMAL
TC4: CAT BED heaters    : LA1/LA2
    Thruster selection   : LA1
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.923 deg
    with XBS2 Lower D/B= 1.260 Upper D/B= 1.873 deg
Line 11:                 *TAGGED 1C,D4          98 054:195945.63
Line 12:                 @Z216 0008             THR+CB SEL-1

TC1: Receiver unit      : 2
    SAA msb              : 1
    SAA det. slit       : MS ONLY
    Conscan control     : OFF
    Constant SAA slew   : OFF
    
```

```

SAA control      : OFF
SPIN control     : OFF
Conscan fail detect : OFF
SAA fail detect  : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode      : PULSED
Firing frequency : 1/2 SPIN
Number of pulses : 13
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle : 3.2 deg
O/L Firing phase : 348.40 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : LA1
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.923 deg
with XBS2 Lower D/B= 1.260 Upper D/B= 1.873 deg
Line 13:          *TAGGED 1C,D5 98 054:200017.63
Line 14:          -Z201 LV1 ON-1
Line 15:          @Z211 EXEC MAN-1
Line 16:          *TAGGED 1C,E8 98 054:201025.64
Line 17:          -Z212 DISA MAN-1
Line 18:          @Z216 0000 THR+CB SEL-1
TC1: Receiver unit : 2
SAA msb            : 1
SAA det. slit     : MS ONLY
Conscan control   : OFF
Constant SAA slew : OFF
SAA control       : OFF
SPIN control      : OFF
Conscan fail detect : OFF
SAA fail detect   : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode       : PULSED
Firing frequency  : 1/2 SPIN
Number of pulses  : 13
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle  : 3.2 deg
O/L Firing phase  : 348.40 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : NONE
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.923 deg
with XBS2 Lower D/B= 1.260 Upper D/B= 1.873 deg
Line 19:          *TAGGED 1D,24 98 054:204225.66
Line 20:          @Z196 CE1/2 OFF
Line 21:          BLKEND
    
```

B.5 Slew 4

```

X872 PREC055:00:00:00                                21
055:00:00:00.0  BLKSTART      872
                  *TAGGED 26,5B          980224:174034.61
                  @Z194                  CE ON
                  *TAGGED 26,5C          980224:174106.61
                  -Z213 8486             TC1
                  -Z214 100B             SET NO. PULSES
                  -Z215 13CF             FIRE ANGLE&PHASE
                  -Z216 0808             SELECT THRUSTER
                  @Z217 885B             SET SAA DB
                  *TAGGED 27,28          980224:192954.69
                  @Z216 0008             CB HEATERS OFF
                  *TAGGED 27,29          980224:193026.69
                  -Z201                   LV ON
                  @Z211                   EXECUTE MAN
                  *TAGGED 27,3B          980224:194002.70
                  -Z212                   DISABLE MAN
                  @Z216 0000             DESELECT THR
                  *TAGGED 27,77          980224:201202.72
                  @Z196                   CE OFF
                  BLKEND
    
```

```

Analysis of FDS file FDS$Dir:X872.DAT
=====
Line 1:X872 PREC055:00:00:00                                21
Line 2:055:00:00:00.0  BLKSTART      872
Line 3:                  *TAGGED 26,5B          98 055:174034.61
Line 4:                  @Z194                  CE-1 ON
Line 5:                  *TAGGED 26,5C          98 055:174106.61
Line 6:                  -Z213 8486             AOCE MODE-1
Line 7:                  -Z214 100B             TP NO+MODE-1
Line 8:                  -Z215 13CF             TP DEL+WID-1
Line 9:                  -Z216 0808             THR+CB SEL-1
Line 10:                 @Z217 885B             SAA DB-1

TC1: Receiver unit      : 2
    SAA msb              : 1
    SAA det. slit       : MS ONLY
    Conscan control     : OFF
    Constant SAA slew   : OFF
    SAA control         : OFF
    SPIN control        : OFF
    Conscan fail detect : OFF
    SAA fail detect     : ON
    SPIN fail detect    : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
    Firing mode         : PULSED
    Firing frequency    : 1/2 SPIN
    Number of pulses    : 11
TC3: O/L Thruster dir.  : AXIAL
    O/L Firing angle    : 3.2 deg
    O/L Firing phase    : 342.77 deg
    Pulses /Firing spin : 1
    D-V failure mode 2  : NORMAL
TC4: CAT BED heaters   : LA1/LA2
    Thruster selection  : LA1
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.903 deg
    with XBS2 Lower D/B= 1.260 Upper D/B= 1.853 deg
Line 11:                 *TAGGED 27,28          98 055:192954.69
Line 12:                 @Z216 0008             THR+CB SEL-1

TC1: Receiver unit      : 2
    SAA msb              : 1
    SAA det. slit       : MS ONLY
    Conscan control     : OFF
    Constant SAA slew   : OFF
    
```

```

SAA control      : OFF
SPIN control     : OFF
Conscan fail detect : OFF
SAA fail detect  : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode      : PULSED
Firing frequency  : 1/2 SPIN
Number of pulses  : 11
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle  : 3.2 deg
O/L Firing phase  : 342.77 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : LA1
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.903 deg
with XBS2 Lower D/B= 1.260 Upper D/B= 1.853 deg
Line 13:          *TAGGED 27,29 98 055:193026.69
Line 14:          -Z201 LV1 ON-1
Line 15:          @Z211 EXEC MAN-1
Line 16:          *TAGGED 27,3B 98 055:194002.70
Line 17:          -Z212 DISA MAN-1
Line 18:          @Z216 0000 THR+CB SEL-1
TC1: Receiver unit : 2
SAA msb            : 1
SAA det. slit     : MS ONLY
Conscan control   : OFF
Constant SAA slew : OFF
SAA control       : OFF
SPIN control      : OFF
Conscan fail detect : OFF
SAA fail detect   : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode       : PULSED
Firing frequency  : 1/2 SPIN
Number of pulses  : 11
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle  : 3.2 deg
O/L Firing phase  : 342.77 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : NONE
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.903 deg
with XBS2 Lower D/B= 1.260 Upper D/B= 1.853 deg
Line 19:          *TAGGED 27,77 98 055:201202.72
Line 20:          @Z196 CE1/2 OFF
Line 21:          BLKEND
    
```

B.6 Slew 5

X873 PREC056:00:00:00		21
056:00:00:00.0	BLKSTART 873	
	*TAGGED 30,E7	980225:174035.69
	@Z194	CE ON
	*TAGGED 30,E8	980225:174107.69
	-Z213 8486	TC1
	-Z214 100A	SET NO. PULSES
	-Z215 13B8	FIRE ANGLE&PHASE
	-Z216 0808	SELECT THRUSTER
	@Z217 8859	SET SAA DB
	*TAGGED 31,B4	980225:192955.77
	@Z216 0008	CB HEATERS OFF
	*TAGGED 31,B5	980225:193027.77
	-Z201	LV ON
	@Z211	EXECUTE MAN
	*TAGGED 31,C6	980225:193931.77
	-Z212	DISABLE MAN
	@Z216 0000	DESELECT THR
	*TAGGED 32,02	980225:201131.80
	@Z196	CE OFF
	BLKEND	

Analysis of FDS file FDS\$Dir:X873.DAT		
=====		
Line 1:	X873 PREC056:00:00:00	21
Line 2:	056:00:00:00.0 BLKSTART 873	
Line 3:	*TAGGED 30,E7	98 056:174035.69
Line 4:	@Z194	CE-1 ON
Line 5:	*TAGGED 30,E8	98 056:174107.69
Line 6:	-Z213 8486	AOCE MODE-1
Line 7:	-Z214 100A	TP NO+MODE-1
Line 8:	-Z215 13B8	TP DEL+WID-1
Line 9:	-Z216 0808	THR+CB SEL-1
Line 10:	@Z217 8859	SAA DB-1
	TC1: Receiver unit	: 2
	SAA msb	: 1
	SAA det. slit	: MS ONLY
	Conscan control	: OFF
	Constant SAA slew	: OFF
	SAA control	: OFF
	SPIN control	: OFF
	Conscan fail detect	: OFF
	SAA fail detect	: ON
	SPIN fail detect	: ON D/B= 5+/-0.2 RPM
	TC2: THRUST fail detect	: OFF
	Firing mode	: PULSED
	Firing frequency	: 1/2 SPIN
	Number of pulses	: 10
	TC3: O/L Thruster dir.	: AXIAL
	O/L Firing angle	: 3.2 deg
	O/L Firing phase	: 334.69 deg
	Pulses /Firing spin	: 1
	D-V failure mode 2	: NORMAL
	TC4: CAT BED heaters	: LA1/LA2
	Thruster selection	: LA1
	TC5: with XBS1 Lower D/B=	1.294 Upper D/B= 1.944 deg
	with XBS2 Lower D/B=	1.260 Upper D/B= 1.893 deg
Line 11:	*TAGGED 31,B4	98 056:192955.77
Line 12:	@Z216 0008	THR+CB SEL-1
	TC1: Receiver unit	: 2
	SAA msb	: 1
	SAA det. slit	: MS ONLY
	Conscan control	: OFF
	Constant SAA slew	: OFF

```

SAA control      : OFF
SPIN control     : OFF
Conscan fail detect : OFF
SAA fail detect  : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode      : PULSED
Firing frequency : 1/2 SPIN
Number of pulses : 10
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle : 3.2 deg
O/L Firing phase : 334.69 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : LA1
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.944 deg
with XBS2 Lower D/B= 1.260 Upper D/B= 1.893 deg
Line 13:          *TAGGED 31,B5 98 056:193027.77
Line 14:          -Z201 LV1 ON-1
Line 15:          @Z211 EXEC MAN-1
Line 16:          *TAGGED 31,C6 98 056:193931.77
Line 17:          -Z212 DISA MAN-1
Line 18:          @Z216 0000 THR+CB SEL-1
TC1: Receiver unit : 2
SAA msb            : 1
SAA det. slit     : MS ONLY
Conscan control   : OFF
Constant SAA slew : OFF
SAA control       : OFF
SPIN control      : OFF
Conscan fail detect : OFF
SAA fail detect   : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode       : PULSED
Firing frequency  : 1/2 SPIN
Number of pulses  : 10
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle  : 3.2 deg
O/L Firing phase  : 334.69 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : NONE
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.944 deg
with XBS2 Lower D/B= 1.260 Upper D/B= 1.893 deg
Line 19:          *TAGGED 32,02 98 056:201131.80
Line 20:          @Z196 CE1/2 OFF
Line 21:          BLKEND
    
```

B.7 Slew 6

```

X874 PREC057:00:00:00                                21
057:00:00:00.0  BLKSTART      874
                  *TAGGED 3B,73      980226:174036.77
                  @Z194                CE ON
                  *TAGGED 3B,74      980226:174108.77
                  -Z213 8486          TC1
                  -Z214 100A          SET NO. PULSES
                  -Z215 13C6          FIRE ANGLE&PHASE
                  -Z216 0808          SELECT THRUSTER
                  @Z217 885B          SET SAA DB
                  *TAGGED 3C,40      980226:192956.85
                  @Z216 0008          CB HEATERS OFF
                  *TAGGED 3C,41      980226:193028.85
                  -Z201                LV ON
                  @Z211                EXECUTE MAN
                  *TAGGED 3C,52      980226:193932.85
                  -Z212                DISABLE MAN
                  @Z216 0000          DESELECT THR
                  *TAGGED 3C,8E      980226:201132.88
                  @Z196                CE OFF
                  BLKEND
    
```

```

Analysis of FDS file FDS$Dir:X874.DAT
=====
Line 1:X874 PREC057:00:00:00                                21
Line 2:057:00:00:00.0  BLKSTART      874
Line 3:                  *TAGGED 3B,73      98 057:174036.77
Line 4:                  @Z194                CE-1 ON
Line 5:                  *TAGGED 3B,74      98 057:174108.77
Line 6:                  -Z213 8486          AOCE MODE-1
Line 7:                  -Z214 100A          TP NO+MODE-1
Line 8:                  -Z215 13C6          TP DEL+WID-1
Line 9:                  -Z216 0808          THR+CB SEL-1
Line 10:                 @Z217 885B          SAA DB-1

TC1: Receiver unit      : 2
    SAA msb              : 1
    SAA det. slit       : MS ONLY
    Conscan control     : OFF
    Constant SAA slew   : OFF
    SAA control         : OFF
    SPIN control        : OFF
    Conscan fail detect : OFF
    SAA fail detect     : ON
    SPIN fail detect    : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
    Firing mode         : PULSED
    Firing frequency    : 1/2 SPIN
    Number of pulses    : 10
TC3: O/L Thruster dir.  : AXIAL
    O/L Firing angle    : 3.2 deg
    O/L Firing phase    : 339.61 deg
    Pulses /Firing spin : 1
    D-V failure mode 2  : NORMAL
TC4: CAT BED heaters   : LA1/LA2
    Thruster selection  : LA1
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.903 deg
    with XBS2 Lower D/B= 1.260 Upper D/B= 1.853 deg
Line 11:                 *TAGGED 3C,40      98 057:192956.85
Line 12:                 @Z216 0008          THR+CB SEL-1

TC1: Receiver unit      : 2
    SAA msb              : 1
    SAA det. slit       : MS ONLY
    Conscan control     : OFF
    Constant SAA slew   : OFF
    
```

```

SAA control      : OFF
SPIN control     : OFF
Conscan fail detect : OFF
SAA fail detect  : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode      : PULSED
Firing frequency : 1/2 SPIN
Number of pulses : 10
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle : 3.2 deg
O/L Firing phase : 339.61 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : LA1
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.903 deg
with XBS2 Lower D/B= 1.260 Upper D/B= 1.853 deg
Line 13:          *TAGGED 3C,41 98 057:193028.85
Line 14:          -Z201 LV1 ON-1
Line 15:          @Z211 EXEC MAN-1
Line 16:          *TAGGED 3C,52 98 057:193932.85
Line 17:          -Z212 DISA MAN-1
Line 18:          @Z216 0000 THR+CB SEL-1
TC1: Receiver unit : 2
SAA msb            : 1
SAA det. slit     : MS ONLY
Conscan control   : OFF
Constant SAA slew : OFF
SAA control       : OFF
SPIN control      : OFF
Conscan fail detect : OFF
SAA fail detect   : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode       : PULSED
Firing frequency  : 1/2 SPIN
Number of pulses  : 10
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle  : 3.2 deg
O/L Firing phase  : 339.61 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : NONE
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.903 deg
with XBS2 Lower D/B= 1.260 Upper D/B= 1.853 deg
Line 19:          *TAGGED 3C,8E 98 057:201132.88
Line 20:          @Z196 CE1/2 OFF
Line 21:          BLKEND
    
```

B.8 Slew 7

```

X875 PREC058:00:00:00                                21
058:00:00:00.0  BLKSTART      875
                  *TAGGED 46,37          980227:181029.87
                  @Z194                  CE ON
                  *TAGGED 46,38          980227:181101.87
                  -Z213 8486             TC1
                  -Z214 1009             SET NO. PULSES
                  -Z215 13A0             FIRE ANGLE&PHASE
                  -Z216 0808             SELECT THRUSTER
                  @Z217 8859             SET SAA DB
                  *TAGGED 47,04          980227:195949.95
                  @Z216 0008             CB HEATERS OFF
                  *TAGGED 47,05          980227:200021.95
                  -Z201                   LV ON
                  @Z211                   EXECUTE MAN
                  *TAGGED 47,15          980227:200853.96
                  -Z212                   DISABLE MAN
                  @Z216 0000             DESELECT THR
                  *TAGGED 47,51          980227:204053.98
                  @Z196                   CE OFF
                  BLKEND
    
```

```

Analysis of FDS file FDS$Dir:X875.DAT
=====
Line 1:X875 PREC058:00:00:00                                21
Line 2:058:00:00:00.0  BLKSTART      875
Line 3:                  *TAGGED 46,37          98 058:181029.87
Line 4:                  @Z194                  CE-1 ON
Line 5:                  *TAGGED 46,38          98 058:181101.87
Line 6:                  -Z213 8486             AOCE MODE-1
Line 7:                  -Z214 1009             TP NO+MODE-1
Line 8:                  -Z215 13A0             TP DEL+WID-1
Line 9:                  -Z216 0808             THR+CB SEL-1
Line 10:                 @Z217 8859             SAA DB-1

TC1: Receiver unit      : 2
    SAA msb              : 1
    SAA det. slit       : MS ONLY
    Conscan control     : OFF
    Constant SAA slew   : OFF
    SAA control         : OFF
    SPIN control        : OFF
    Conscan fail detect : OFF
    SAA fail detect     : ON
    SPIN fail detect    : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
    Firing mode         : PULSED
    Firing frequency    : 1/2 SPIN
    Number of pulses    : 9
TC3: O/L Thruster dir.  : AXIAL
    O/L Firing angle    : 3.2 deg
    O/L Firing phase    : 326.25 deg
    Pulses /Firing spin : 1
    D-V failure mode 2  : NORMAL
TC4: CAT BED heaters   : LA1/LA2
    Thruster selection  : LA1
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.944 deg
    with XBS2 Lower D/B= 1.260 Upper D/B= 1.893 deg
Line 11:                 *TAGGED 47,04          98 058:195949.95
Line 12:                 @Z216 0008             THR+CB SEL-1

TC1: Receiver unit      : 2
    SAA msb              : 1
    SAA det. slit       : MS ONLY
    Conscan control     : OFF
    Constant SAA slew   : OFF
    
```

```

SAA control      : OFF
SPIN control     : OFF
Conscan fail detect : OFF
SAA fail detect  : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode      : PULSED
Firing frequency : 1/2 SPIN
Number of pulses : 9
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle : 3.2 deg
O/L Firing phase : 326.25 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : LA1
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.944 deg
with XBS2 Lower D/B= 1.260 Upper D/B= 1.893 deg
Line 13:          *TAGGED 47,05 98 058:200021.95
Line 14:          -Z201 LV1 ON-1
Line 15:          @Z211 EXEC MAN-1
Line 16:          *TAGGED 47,15 98 058:200853.96
Line 17:          -Z212 DISA MAN-1
Line 18:          @Z216 0000 THR+CB SEL-1
TC1: Receiver unit : 2
SAA msb            : 1
SAA det. slit     : MS ONLY
Conscan control   : OFF
Constant SAA slew : OFF
SAA control       : OFF
SPIN control      : OFF
Conscan fail detect : OFF
SAA fail detect   : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode       : PULSED
Firing frequency  : 1/2 SPIN
Number of pulses  : 9
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle  : 3.2 deg
O/L Firing phase  : 326.25 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : NONE
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.944 deg
with XBS2 Lower D/B= 1.260 Upper D/B= 1.893 deg
Line 19:          *TAGGED 47,51 98 058:204053.98
Line 20:          @Z196 CE1/2 OFF
Line 21:          BLKEND
    
```

B.9 Slew 8

```

X876 PREC059:00:00:00                                21
059:00:00:00.0  BLKSTART      876
                  *TAGGED 50,8B          980228:174038.92
                  @Z194                  CE ON
                  *TAGGED 50,8C          980228:174110.92
                  -Z213 8486             TC1
                  -Z214 100C             SET NO. PULSES
                  -Z215 13D1             FIRE ANGLE&PHASE
                  -Z216 0808             SELECT THRUSTER
                  @Z217 885B             SET SAA DB
                  *TAGGED 51,58          980228:192959.01
                  @Z216 0008             CB HEATERS OFF
                  *TAGGED 51,59          980228:193031.01
                  -Z201                   LV ON
                  @Z211                   EXECUTE MAN
                  *TAGGED 51,6C          980228:194039.01
                  -Z212                   DISABLE MAN
                  @Z216 0000             DESELECT THR
                  *TAGGED 51,A8          980228:201239.04
                  @Z196                   CE OFF
                  BLKEND
    
```

```

Analysis of FDS file FDS$Dir:X876.DAT
=====
Line 1:X876 PREC059:00:00:00                                21
Line 2:059:00:00:00.0  BLKSTART      876
Line 3:                  *TAGGED 50,8B          98 059:174038.92
Line 4:                  @Z194                  CE-1 ON
Line 5:                  *TAGGED 50,8C          98 059:174110.92
Line 6:                  -Z213 8486             AOCE MODE-1
Line 7:                  -Z214 100C             TP NO+MODE-1
Line 8:                  -Z215 13D1             TP DEL+WID-1
Line 9:                  -Z216 0808             THR+CB SEL-1
Line 10:                 @Z217 885B             SAA DB-1

TC1: Receiver unit      : 2
    SAA msb              : 1
    SAA det. slit        : MS ONLY
    Conscan control      : OFF
    Constant SAA slew    : OFF
    SAA control          : OFF
    SPIN control         : OFF
    Conscan fail detect  : OFF
    SAA fail detect      : ON
    SPIN fail detect     : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
    Firing mode          : PULSED
    Firing frequency     : 1/2 SPIN
    Number of pulses     : 12
TC3: O/L Thruster dir.  : AXIAL
    O/L Firing angle     : 3.2 deg
    O/L Firing phase     : 343.48 deg
    Pulses /Firing spin  : 1
    D-V failure mode 2   : NORMAL
TC4: CAT BED heaters    : LA1/LA2
    Thruster selection   : LA1
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.903 deg
    with XBS2 Lower D/B= 1.260 Upper D/B= 1.853 deg
Line 11:                 *TAGGED 51,58          98 059:192959.01
Line 12:                 @Z216 0008             THR+CB SEL-1

TC1: Receiver unit      : 2
    SAA msb              : 1
    SAA det. slit        : MS ONLY
    Conscan control      : OFF
    Constant SAA slew    : OFF
    
```

```

SAA control      : OFF
SPIN control     : OFF
Conscan fail detect : OFF
SAA fail detect  : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode      : PULSED
Firing frequency : 1/2 SPIN
Number of pulses : 12
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle : 3.2 deg
O/L Firing phase : 343.48 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : LA1
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.903 deg
with XBS2 Lower D/B= 1.260 Upper D/B= 1.853 deg
Line 13:          *TAGGED 51,59 98 059:193031.01
Line 14:          -Z201 LV1 ON-1
Line 15:          @Z211 EXEC MAN-1
Line 16:          *TAGGED 51,6C 98 059:194039.01
Line 17:          -Z212 DISA MAN-1
Line 18:          @Z216 0000 THR+CB SEL-1
TC1: Receiver unit : 2
SAA msb            : 1
SAA det. slit     : MS ONLY
Conscan control   : OFF
Constant SAA slew : OFF
SAA control       : OFF
SPIN control      : OFF
Conscan fail detect : OFF
SAA fail detect   : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode       : PULSED
Firing frequency  : 1/2 SPIN
Number of pulses  : 12
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle  : 3.2 deg
O/L Firing phase  : 343.48 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : NONE
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.903 deg
with XBS2 Lower D/B= 1.260 Upper D/B= 1.853 deg
Line 19:          *TAGGED 51,A8 98 059:201239.04
Line 20:          @Z196 CE1/2 OFF
Line 21:          BLKEND
    
```

B.10 Slew 9

```

X877 PREC060:00:00:00                                21
060:00:00:00.0  BLKSTART      877
                  *TAGGED 5B,17      980301:174040.00
                  @Z194                CE ON
                  *TAGGED 5B,18      980301:174112.00
                  -Z213 8486          TC1
                  -Z214 100B          SET NO. PULSES
                  -Z215 13C5          FIRE ANGLE&PHASE
                  -Z216 0808          SELECT THRUSTER
                  @Z217 885A          SET SAA DB
                  *TAGGED 5B,E4      980301:193000.09
                  @Z216 0008          CB HEATERS OFF
                  *TAGGED 5B,E5      980301:193032.09
                  -Z201                LV ON
                  @Z211                EXECUTE MAN
                  *TAGGED 5B,F7      980301:194008.09
                  -Z212                DISABLE MAN
                  @Z216 0000          DESELECT THR
                  *TAGGED 5C,33      980301:201208.12
                  @Z196                CE OFF
                  BLKEND
    
```

```

Analysis of FDS file FDS$Dir:X877.DAT
=====
Line 1:X877 PREC060:00:00:00                                21
Line 2:060:00:00:00.0  BLKSTART      877
Line 3:                  *TAGGED 5B,17      98 060:174040.00
Line 4:                  @Z194                CE-1 ON
Line 5:                  *TAGGED 5B,18      98 060:174112.00
Line 6:                  -Z213 8486          AOCE MODE-1
Line 7:                  -Z214 100B          TP NO+MODE-1
Line 8:                  -Z215 13C5          TP DEL+WID-1
Line 9:                  -Z216 0808          THR+CB SEL-1
Line 10:                 @Z217 885A          SAA DB-1

TC1: Receiver unit      : 2
    SAA msb              : 1
    SAA det. slit       : MS ONLY
    Conscan control     : OFF
    Constant SAA slew   : OFF
    SAA control         : OFF
    SPIN control        : OFF
    Conscan fail detect : OFF
    SAA fail detect     : ON
    SPIN fail detect    : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
    Firing mode          : PULSED
    Firing frequency     : 1/2 SPIN
    Number of pulses    : 11
TC3: O/L Thruster dir.  : AXIAL
    O/L Firing angle    : 3.2 deg
    O/L Firing phase    : 339.26 deg
    Pulses /Firing spin : 1
    D-V failure mode 2  : NORMAL
TC4: CAT BED heaters   : LA1/LA2
    Thruster selection  : LA1
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.923 deg
    with XBS2 Lower D/B= 1.260 Upper D/B= 1.873 deg
Line 11:                 *TAGGED 5B,E4      98 060:193000.09
Line 12:                 @Z216 0008          THR+CB SEL-1

TC1: Receiver unit      : 2
    SAA msb              : 1
    SAA det. slit       : MS ONLY
    Conscan control     : OFF
    Constant SAA slew   : OFF
    
```

```

SAA control      : OFF
SPIN control     : OFF
Conscan fail detect : OFF
SAA fail detect  : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode      : PULSED
Firing frequency : 1/2 SPIN
Number of pulses : 11
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle : 3.2 deg
O/L Firing phase : 339.26 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : LA1
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.923 deg
with XBS2 Lower D/B= 1.260 Upper D/B= 1.873 deg
Line 13:          *TAGGED 5B,E5 98 060:193032.09
Line 14:          -Z201 LV1 ON-1
Line 15:          @Z211 EXEC MAN-1
Line 16:          *TAGGED 5B,F7 98 060:194008.09
Line 17:          -Z212 DISA MAN-1
Line 18:          @Z216 0000 THR+CB SEL-1
TC1: Receiver unit : 2
SAA msb            : 1
SAA det. slit     : MS ONLY
Conscan control   : OFF
Constant SAA slew : OFF
SAA control       : OFF
SPIN control      : OFF
Conscan fail detect : OFF
SAA fail detect   : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode       : PULSED
Firing frequency  : 1/2 SPIN
Number of pulses  : 11
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle  : 3.2 deg
O/L Firing phase  : 339.26 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : NONE
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.923 deg
with XBS2 Lower D/B= 1.260 Upper D/B= 1.873 deg
Line 19:          *TAGGED 5C,33 98 060:201208.12
Line 20:          @Z196 CE1/2 OFF
Line 21:          BLKEND
    
```

B.11 Slew 10

```

X878 PREC061:00:00:00                                21
061:00:00:00.0  BLKSTART      878
                  *TAGGED 63,A9      980302:131048.88
                  @Z194              CE ON
                  *TAGGED 63,AA      980302:131120.88
                  -Z213 8486        TC1
                  -Z214 100F        SET NO. PULSES
                  -Z215 13E2        FIRE ANGLE&PHASE
                  -Z216 0808        SELECT THRUSTER
                  @Z217 895B        SET SAA DB
                  *TAGGED 64,76      980302:150008.96
                  @Z216 0008        CB HEATERS OFF
                  *TAGGED 64,77      980302:150040.96
                  -Z201              LV ON
                  @Z211              EXECUTE MAN
                  *TAGGED 64,8C      980302:151152.97
                  -Z212              DISABLE MAN
                  @Z216 0000        DESELECT THR
                  *TAGGED 64,C8      980302:154353.00
                  @Z196              CE OFF
                  BLKEND
    
```

```

Analysis of FDS file FDS$Dir:X878.DAT
=====
Line 1:X878 PREC061:00:00:00                                21
Line 2:061:00:00:00.0  BLKSTART      878
Line 3:                  *TAGGED 63,A9      98 061:131048.88
Line 4:                  @Z194              CE-1 ON
Line 5:                  *TAGGED 63,AA      98 061:131120.88
Line 6:                  -Z213 8486        AOCE MODE-1
Line 7:                  -Z214 100F        TP NO+MODE-1
Line 8:                  -Z215 13E2        TP DEL+WID-1
Line 9:                  -Z216 0808        THR+CB SEL-1
Line 10:                 @Z217 895B        SAA DB-1

TC1: Receiver unit      : 2
    SAA msb              : 1
    SAA det. slit       : MS ONLY
    Conscan control     : OFF
    Constant SAA slew   : OFF
    SAA control         : OFF
    SPIN control        : OFF
    Conscan fail detect : OFF
    SAA fail detect     : ON
    SPIN fail detect    : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
    Firing mode         : PULSED
    Firing frequency    : 1/2 SPIN
    Number of pulses    : 15
TC3: O/L Thruster dir.  : AXIAL
    O/L Firing angle    : 3.2 deg
    O/L Firing phase    : 349.45 deg
    Pulses /Firing spin : 1
    D-V failure mode 2  : NORMAL
TC4: CAT BED heaters   : LA1/LA2
    Thruster selection  : LA1
TC5: with XBS1 Lower D/B= 1.285 Upper D/B= 1.903 deg
    with XBS2 Lower D/B= 1.252 Upper D/B= 1.853 deg
Line 11:                 *TAGGED 64,76      98 061:150008.96
Line 12:                 @Z216 0008        THR+CB SEL-1

TC1: Receiver unit      : 2
    SAA msb              : 1
    SAA det. slit       : MS ONLY
    Conscan control     : OFF
    Constant SAA slew   : OFF
    
```

```

SAA control      : OFF
SPIN control     : OFF
Conscan fail detect : OFF
SAA fail detect  : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode      : PULSED
Firing frequency  : 1/2 SPIN
Number of pulses  : 15
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle  : 3.2 deg
O/L Firing phase  : 349.45 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : LA1
TC5: with XBS1 Lower D/B= 1.285 Upper D/B= 1.903 deg
with XBS2 Lower D/B= 1.252 Upper D/B= 1.853 deg
Line 13:          *TAGGED 64,77 98 061:150040.96
Line 14:          -Z201 LV1 ON-1
Line 15:          @Z211 EXEC MAN-1
Line 16:          *TAGGED 64,8C 98 061:151152.97
Line 17:          -Z212 DISA MAN-1
Line 18:          @Z216 0000 THR+CB SEL-1
TC1: Receiver unit : 2
SAA msb            : 1
SAA det. slit     : MS ONLY
Conscan control   : OFF
Constant SAA slew : OFF
SAA control       : OFF
SPIN control      : OFF
Conscan fail detect : OFF
SAA fail detect   : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode       : PULSED
Firing frequency  : 1/2 SPIN
Number of pulses  : 15
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle  : 3.2 deg
O/L Firing phase  : 349.45 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : NONE
TC5: with XBS1 Lower D/B= 1.285 Upper D/B= 1.903 deg
with XBS2 Lower D/B= 1.252 Upper D/B= 1.853 deg
Line 19:          *TAGGED 64,C8 98 061:154353.00
Line 20:          @Z196 CE1/2 OFF
Line 21:          BLKEND
    
```

B.12 Slew 11

X879 PREC062:00:00:00		21
062:00:00:00.0	BLKSTART 879	
	*TAGGED 6E,35	980303:131049.96
	@Z194	CE ON
	*TAGGED 6E,36	980303:131121.96
	-Z213 8486	TC1
	-Z214 1010	SET NO. PULSES
	-Z215 13C3	FIRE ANGLE&PHASE
	-Z216 0808	SELECT THRUSTER
	@Z217 8858	SET SAA DB
	*TAGGED 6F,02	980303:150010.04
	@Z216 0008	CB HEATERS OFF
	*TAGGED 6F,03	980303:150042.04
	-Z201	LV ON
	@Z211	EXECUTE MAN
	*TAGGED 6F,19	980303:151226.05
	-Z212	DISABLE MAN
	@Z216 0000	DESELECT THR
	*TAGGED 6F,55	980303:154426.08
	@Z196	CE OFF
	BLKEND	

Analysis of FDS file FDS\$Dir:X879.DAT

Line 1:	X879 PREC062:00:00:00		21
Line 2:	062:00:00:00.0	BLKSTART 879	
Line 3:		*TAGGED 6E,35	98 062:131049.96
Line 4:		@Z194	CE-1 ON
Line 5:		*TAGGED 6E,36	98 062:131121.96
Line 6:		-Z213 8486	AOCE MODE-1
Line 7:		-Z214 1010	TP NO+MODE-1
Line 8:		-Z215 13C3	TP DEL+WID-1
Line 9:		-Z216 0808	THR+CB SEL-1
Line 10:		@Z217 8858	SAA DB-1
	TC1: Receiver unit	: 2	
	SAA msb	: 1	
	SAA det. slit	: MS ONLY	
	Conscan control	: OFF	
	Constant SAA slew	: OFF	
	SAA control	: OFF	
	SPIN control	: OFF	
	Conscan fail detect	: OFF	
	SAA fail detect	: ON	
	SPIN fail detect	: ON D/B= 5+/-0.2 RPM	
	TC2: THRUST fail detect	: OFF	
	Firing mode	: PULSED	
	Firing frequency	: 1/2 SPIN	
	Number of pulses	: 16	
	TC3: O/L Thruster dir.	: AXIAL	
	O/L Firing angle	: 3.2 deg	
	O/L Firing phase	: 338.55 deg	
	Pulses /Firing spin	: 1	
	D-V failure mode 2	: NORMAL	
	TC4: CAT BED heaters	: LA1/LA2	
	Thruster selection	: LA1	
	TC5: with XBS1 Lower D/B=	1.294 Upper D/B= 1.966 deg	
	with XBS2 Lower D/B=	1.260 Upper D/B= 1.914 deg	
Line 11:		*TAGGED 6F,02	98 062:150010.04
Line 12:		@Z216 0008	THR+CB SEL-1
	TC1: Receiver unit	: 2	
	SAA msb	: 1	
	SAA det. slit	: MS ONLY	
	Conscan control	: OFF	
	Constant SAA slew	: OFF	

```

SAA control      : OFF
SPIN control     : OFF
Conscan fail detect : OFF
SAA fail detect  : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode      : PULSED
Firing frequency : 1/2 SPIN
Number of pulses : 16
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle : 3.2 deg
O/L Firing phase : 338.55 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : LA1
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.966 deg
with XBS2 Lower D/B= 1.260 Upper D/B= 1.914 deg
Line 13:          *TAGGED 6F,03 98 062:150042.04
Line 14:          -Z201 LV1 ON-1
Line 15:          @Z211 EXEC MAN-1
Line 16:          *TAGGED 6F,19 98 062:151226.05
Line 17:          -Z212 DISA MAN-1
Line 18:          @Z216 0000 THR+CB SEL-1
TC1: Receiver unit : 2
SAA msb            : 1
SAA det. slit     : MS ONLY
Conscan control   : OFF
Constant SAA slew : OFF
SAA control       : OFF
SPIN control      : OFF
Conscan fail detect : OFF
SAA fail detect   : ON
SPIN fail detect  : ON D/B= 5+/-0.2 RPM
TC2: THRUST fail detect : OFF
Firing mode      : PULSED
Firing frequency : 1/2 SPIN
Number of pulses : 16
TC3: O/L Thruster dir. : AXIAL
O/L Firing angle : 3.2 deg
O/L Firing phase : 338.55 deg
Pulses /Firing spin : 1
D-V failure mode 2 : NORMAL
TC4: CAT BED heaters : NONE
Thruster selection : NONE
TC5: with XBS1 Lower D/B= 1.294 Upper D/B= 1.966 deg
with XBS2 Lower D/B= 1.260 Upper D/B= 1.914 deg
Line 19:          *TAGGED 6F,55 98 062:154426.08
Line 20:          @Z196 CE1/2 OFF
Line 21:          BLKEND
    
```

Appendix C Manoeuvre Plots

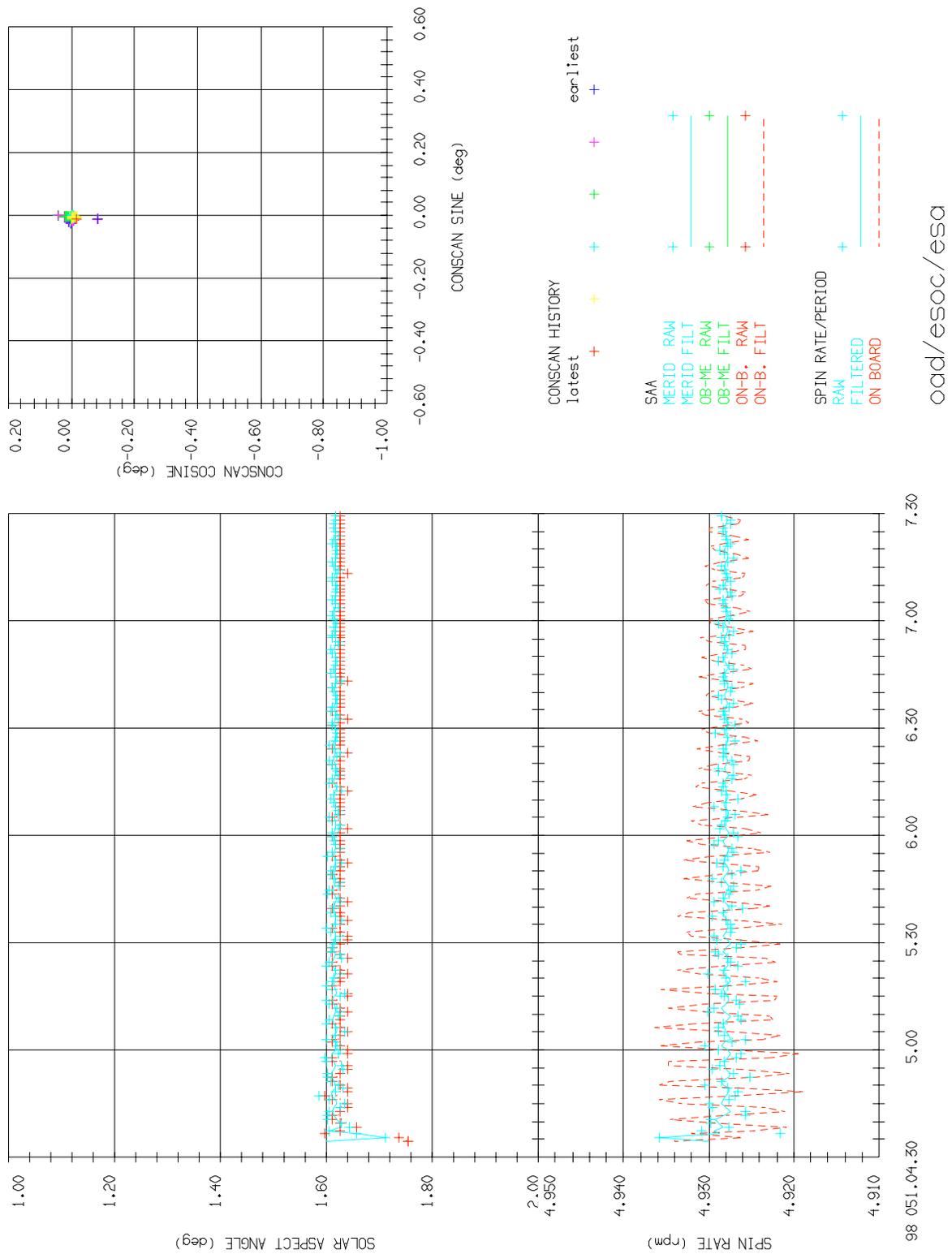


Figure C. 1: Real-Time Monitor Plot of Opposition 5 Slew 0

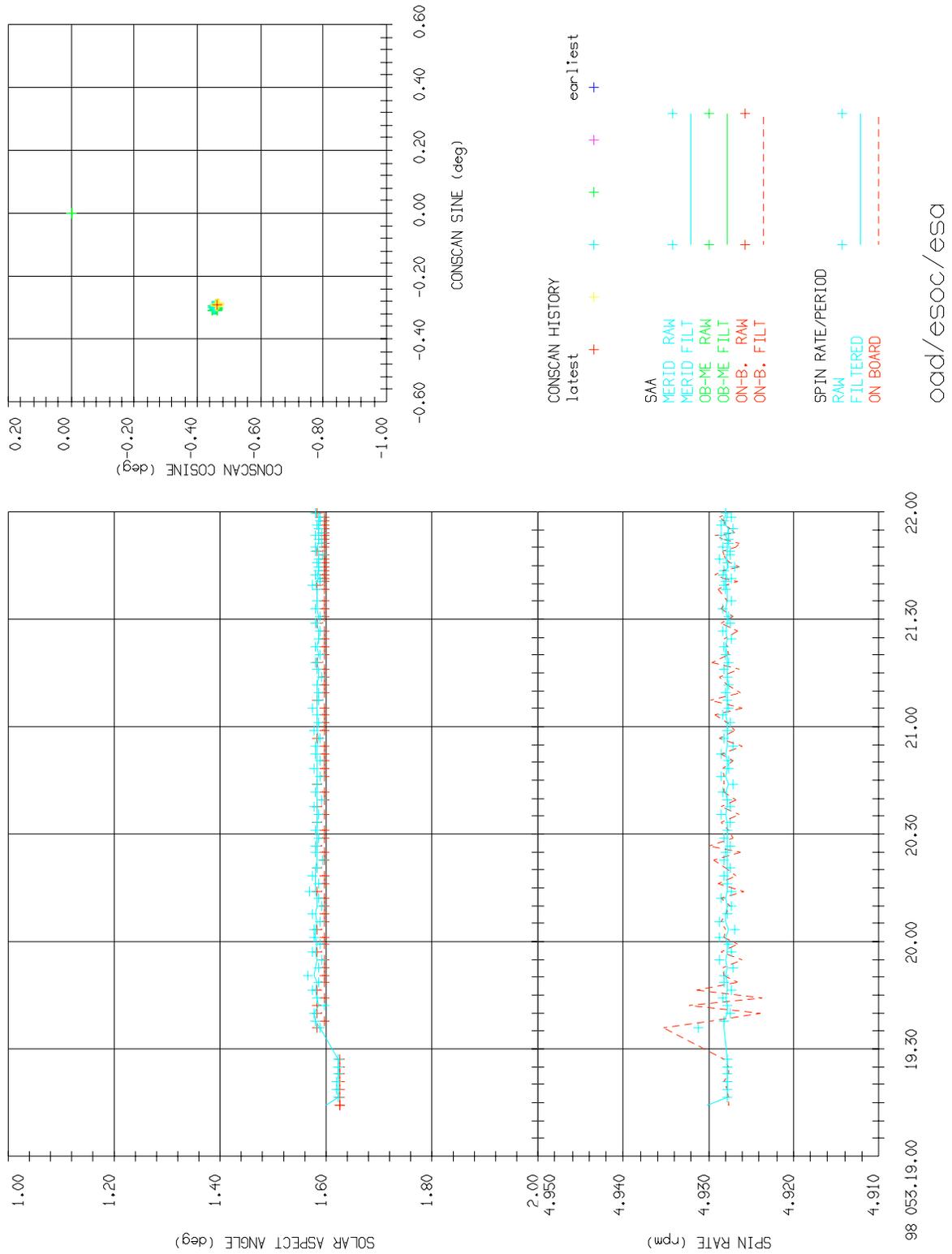


Figure C. 2: Real-Time Monitor Plot of Opposition 5 Slew 1

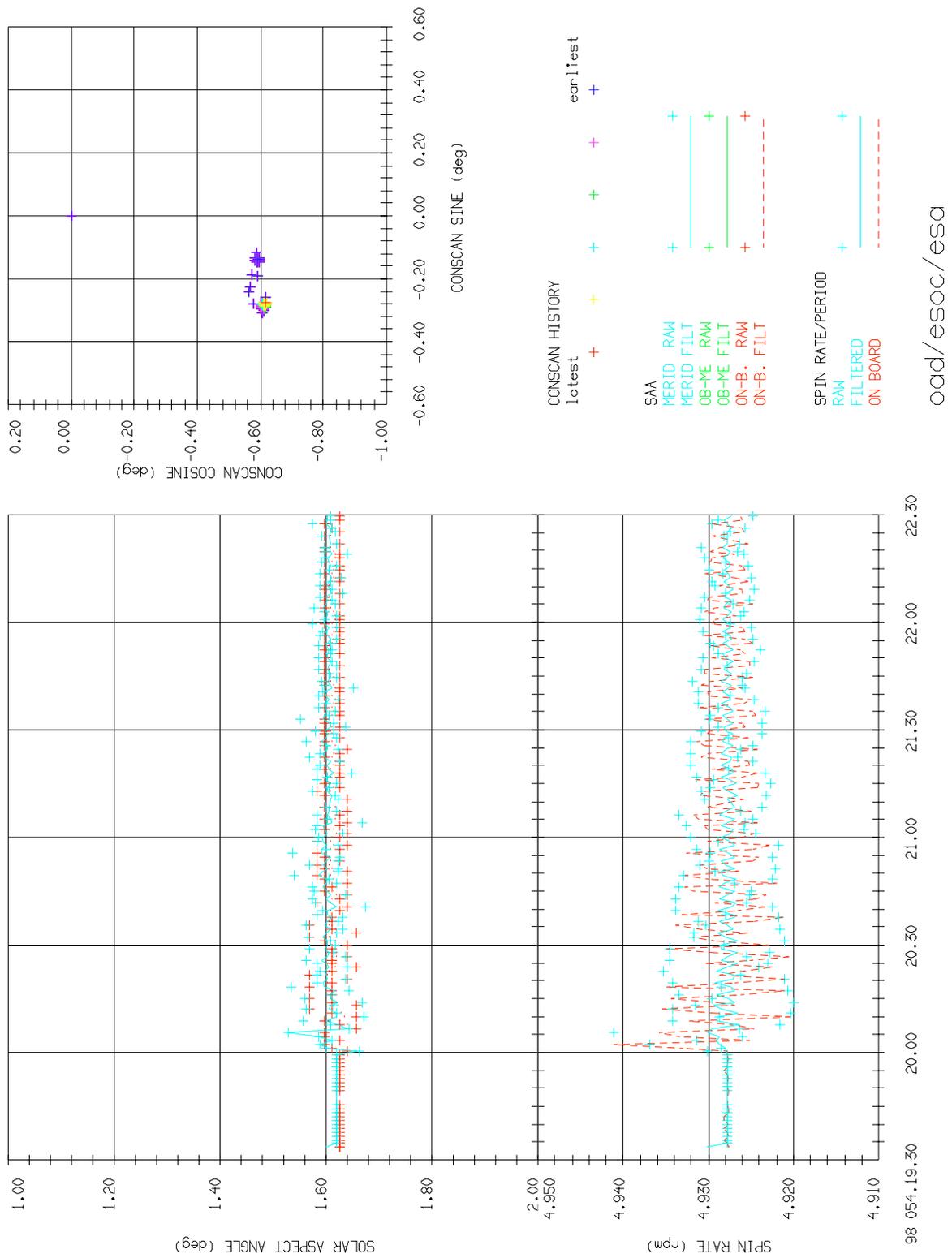


Figure C. 3: Real-Time Monitor Plot of Opposition 5 Slew 2

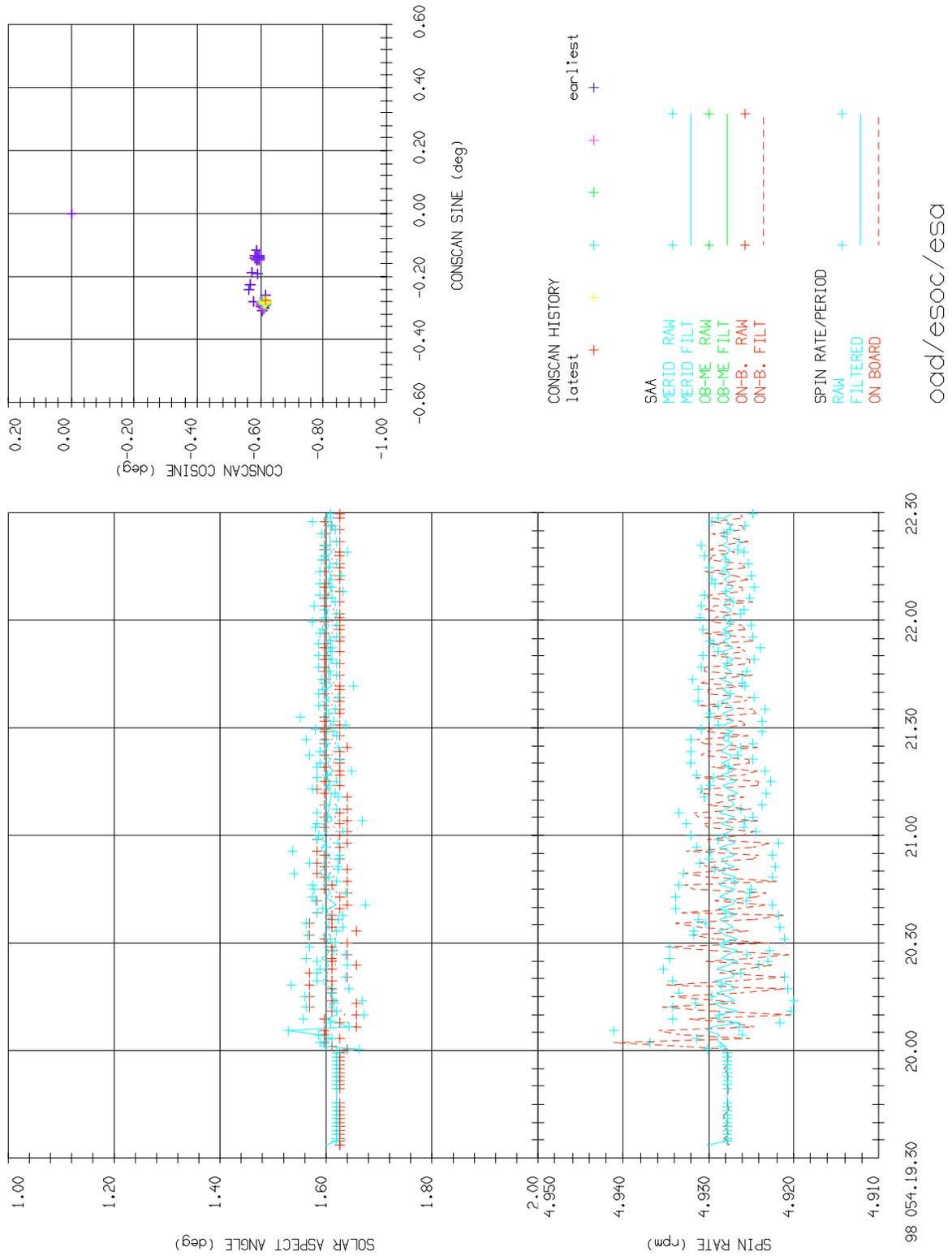


Figure C. 4: Real-Time Monitor Plot of Opposition 5 Slew 3

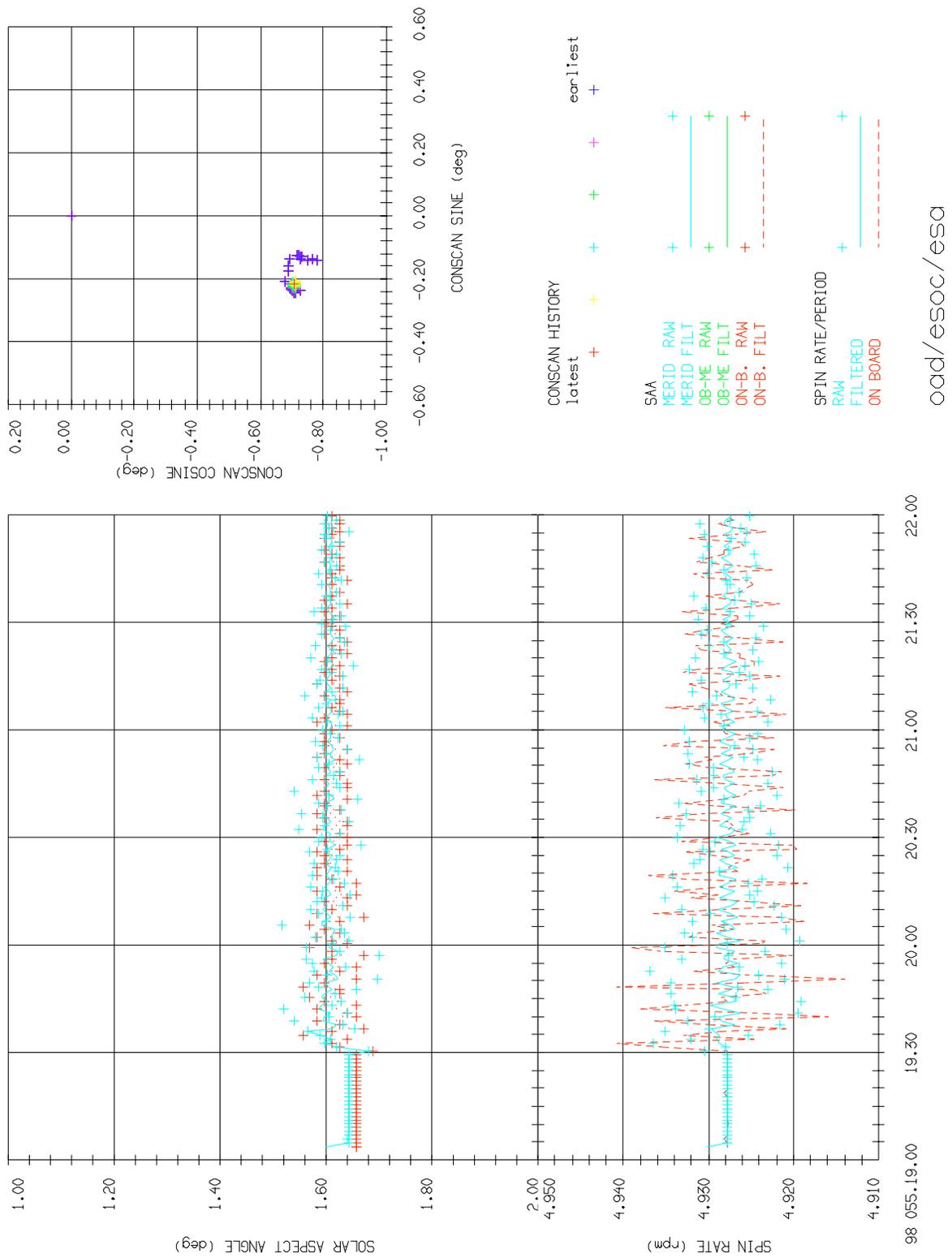


Figure C. 5: Real-Time Monitor Plot of Opposition 5 Slew 4

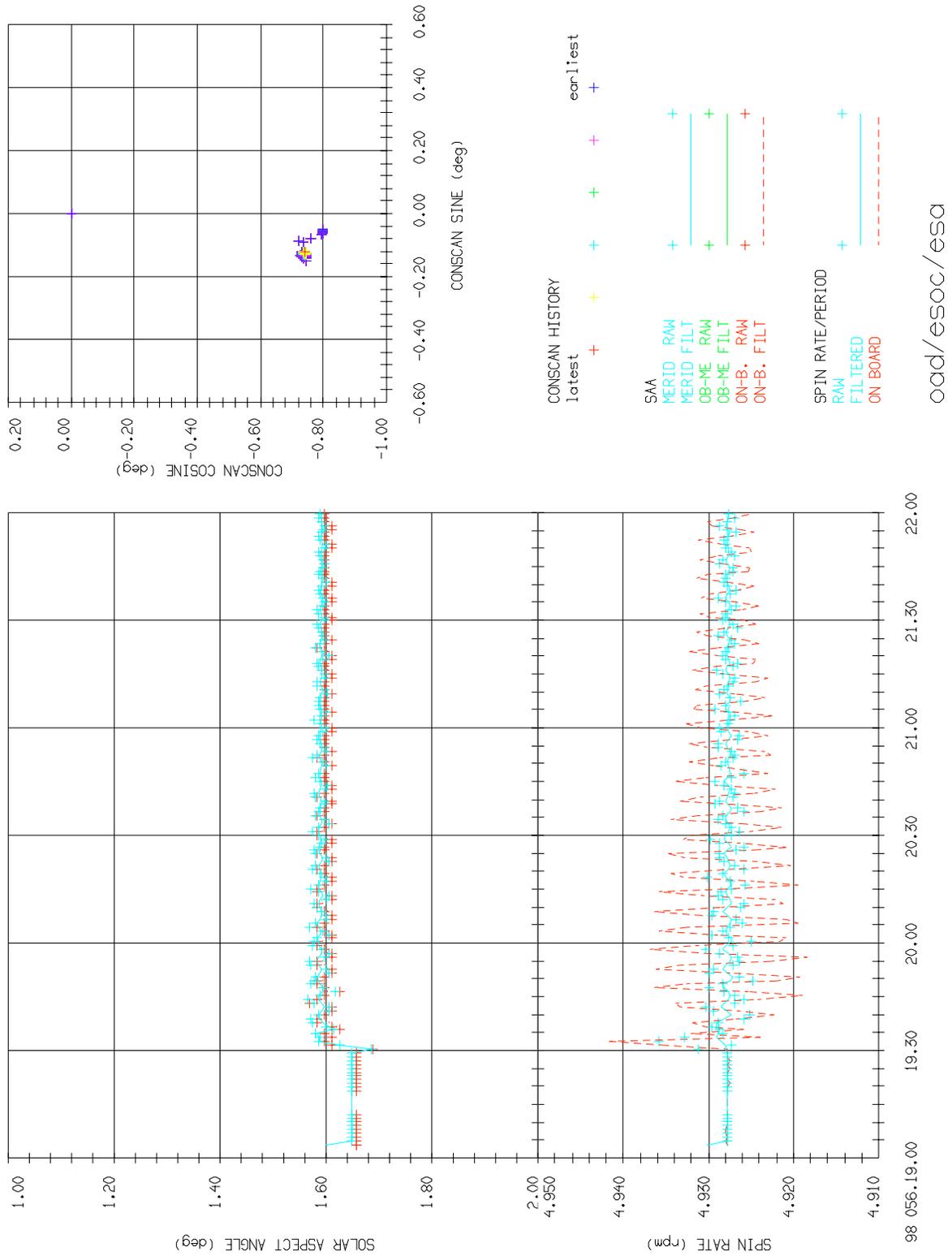


Figure C. 6: Real-Time Monitor Plot of Opposition 5 Slew 5

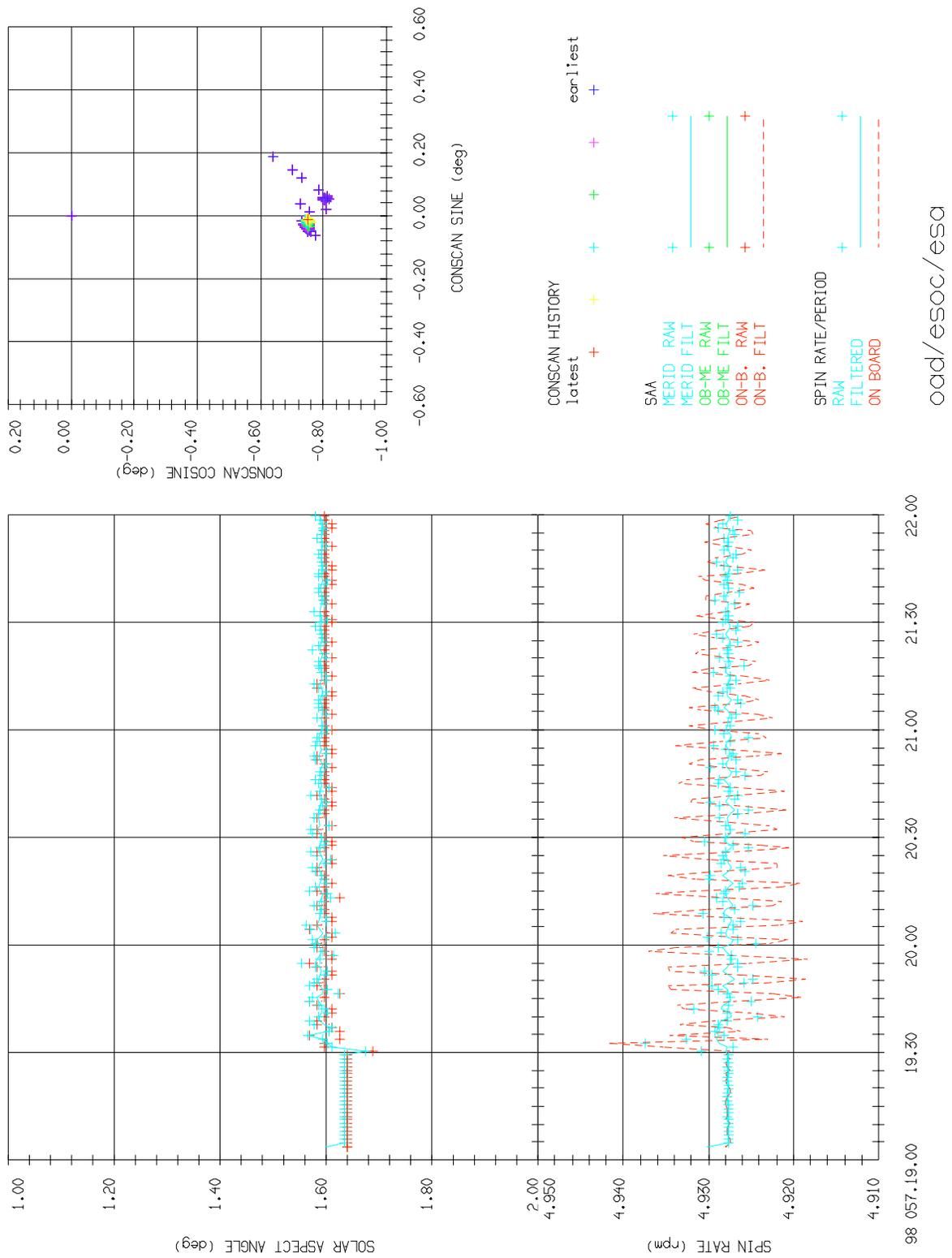


Figure C. 7: Real-Time Monitor Plot of Opposition 5 Slew 6

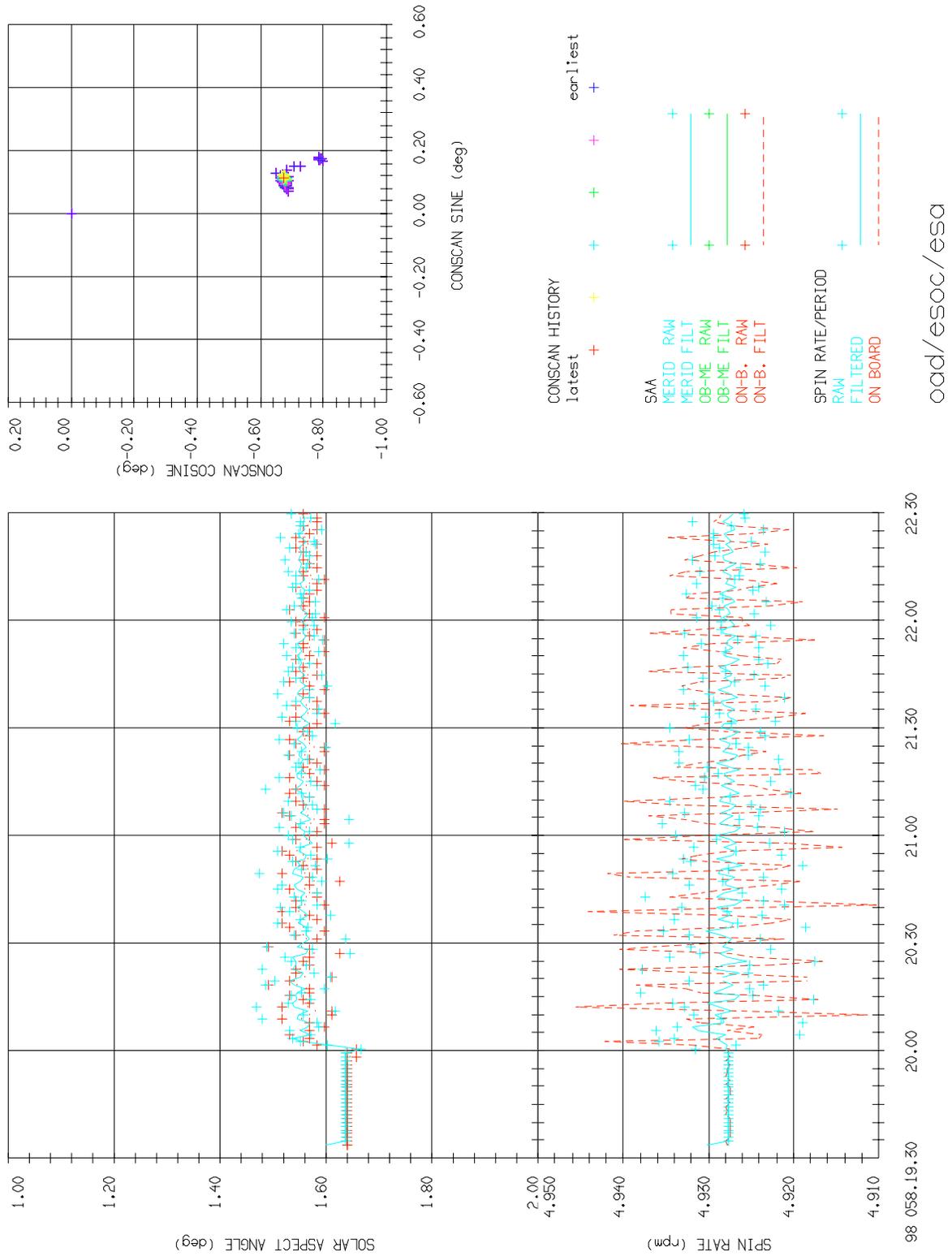


Figure C. 8: Real-Time Monitor Plot of Opposition 5 Slew 7

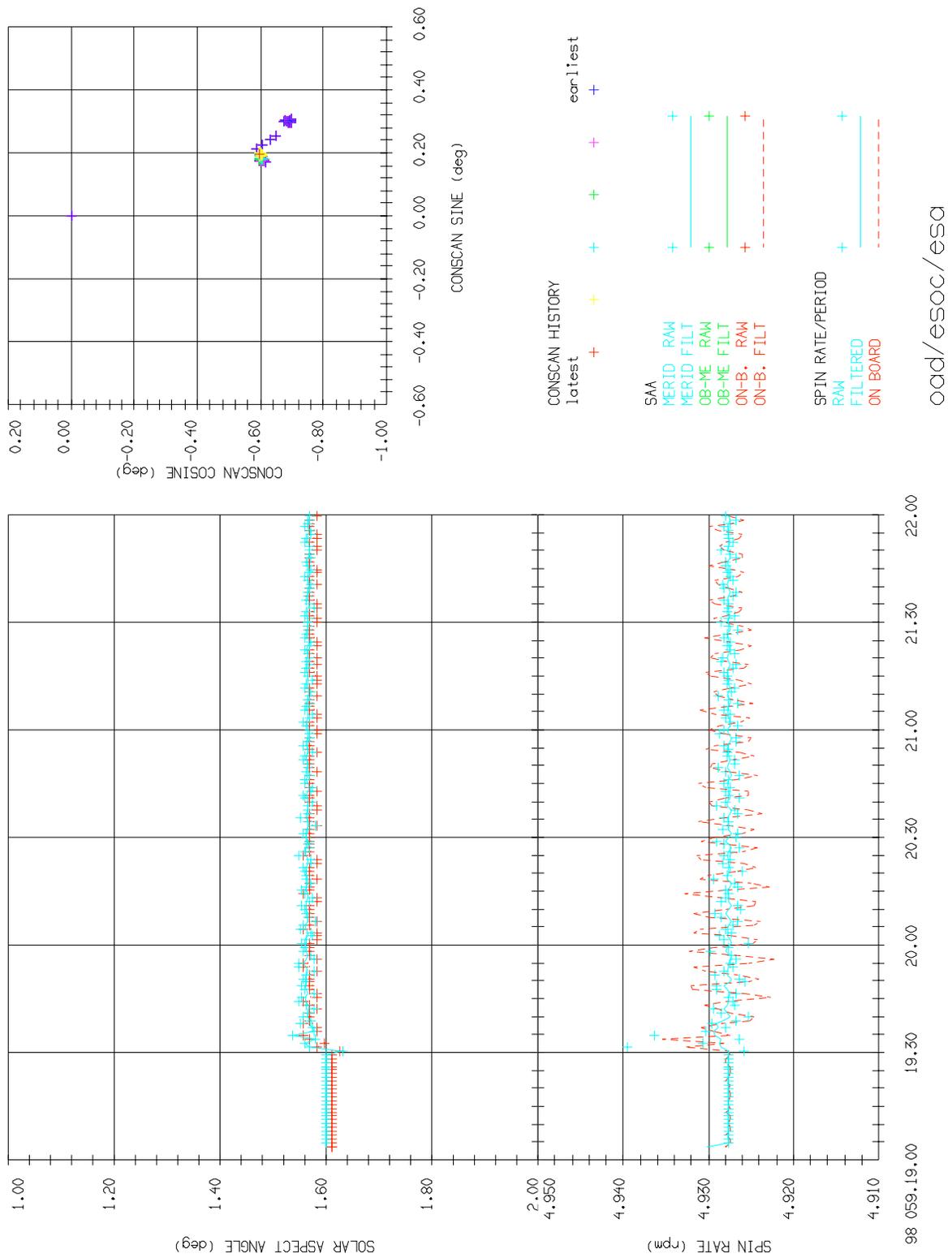


Figure C. 9: Real-Time Monitor Plot of Opposition 5 Slew 8

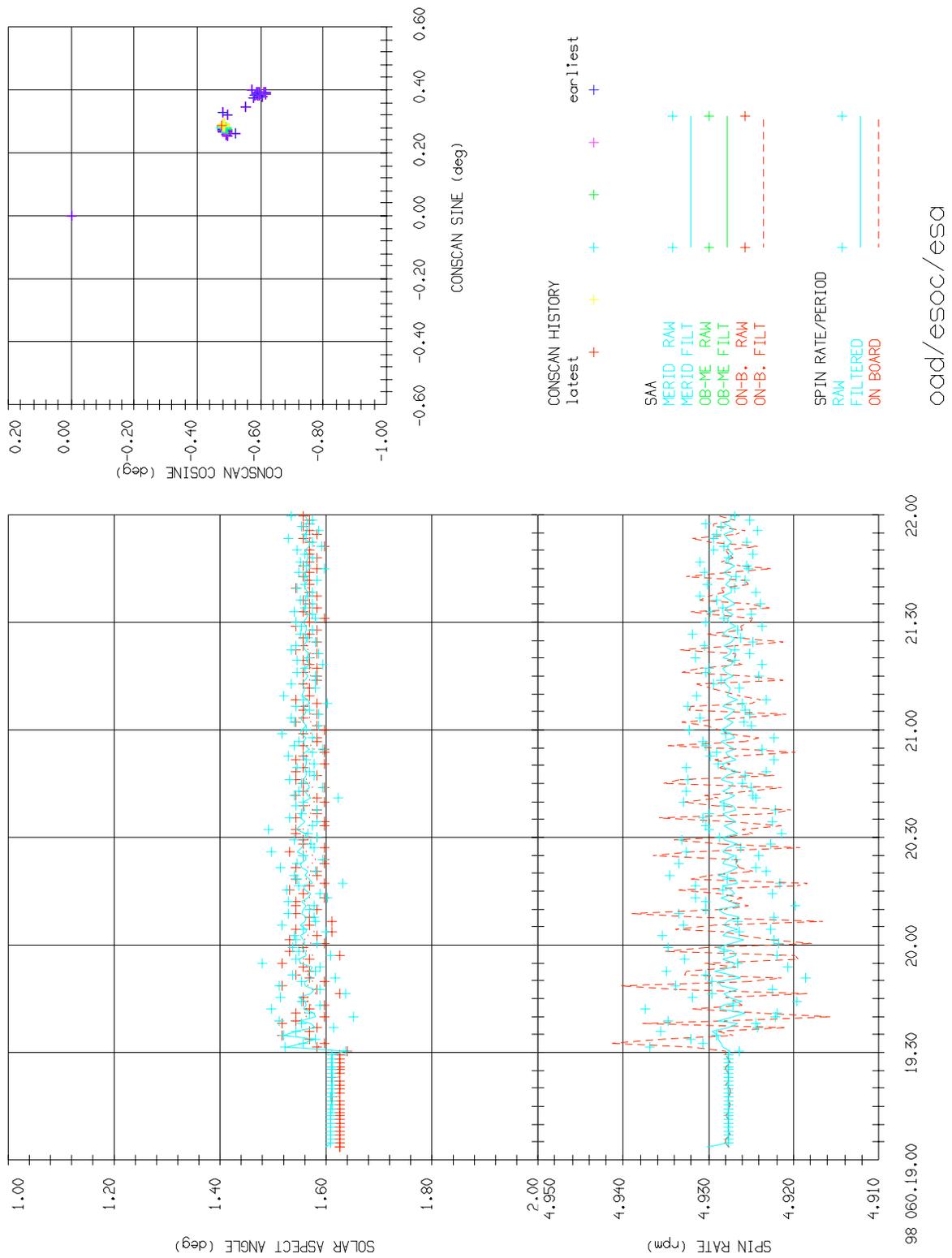


Figure C. 10: Real-Time Monitor Plot of Opposition 5 Slew 9

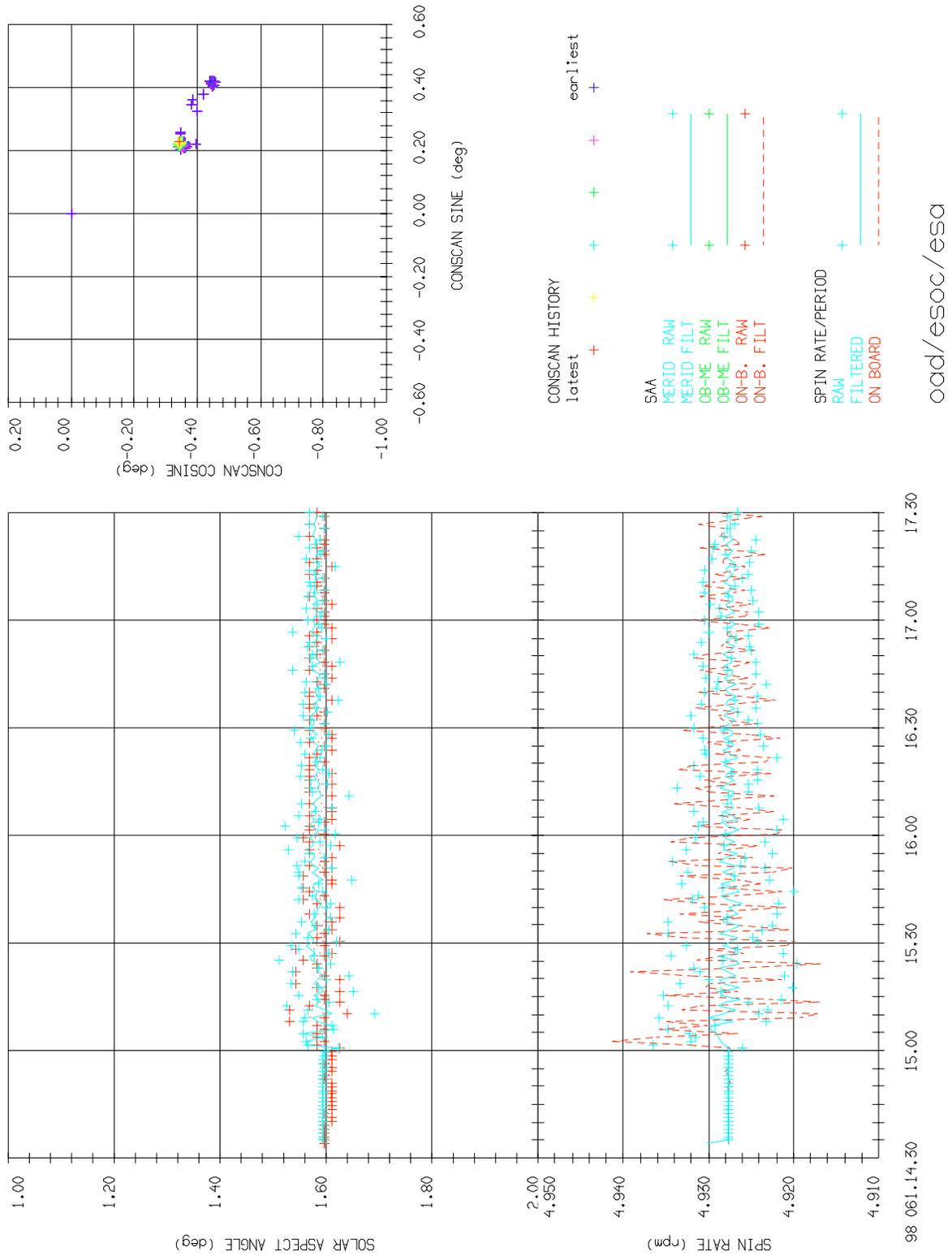


Figure C. 11: Real-Time Monitor Plot of Opposition 5 Slew 10

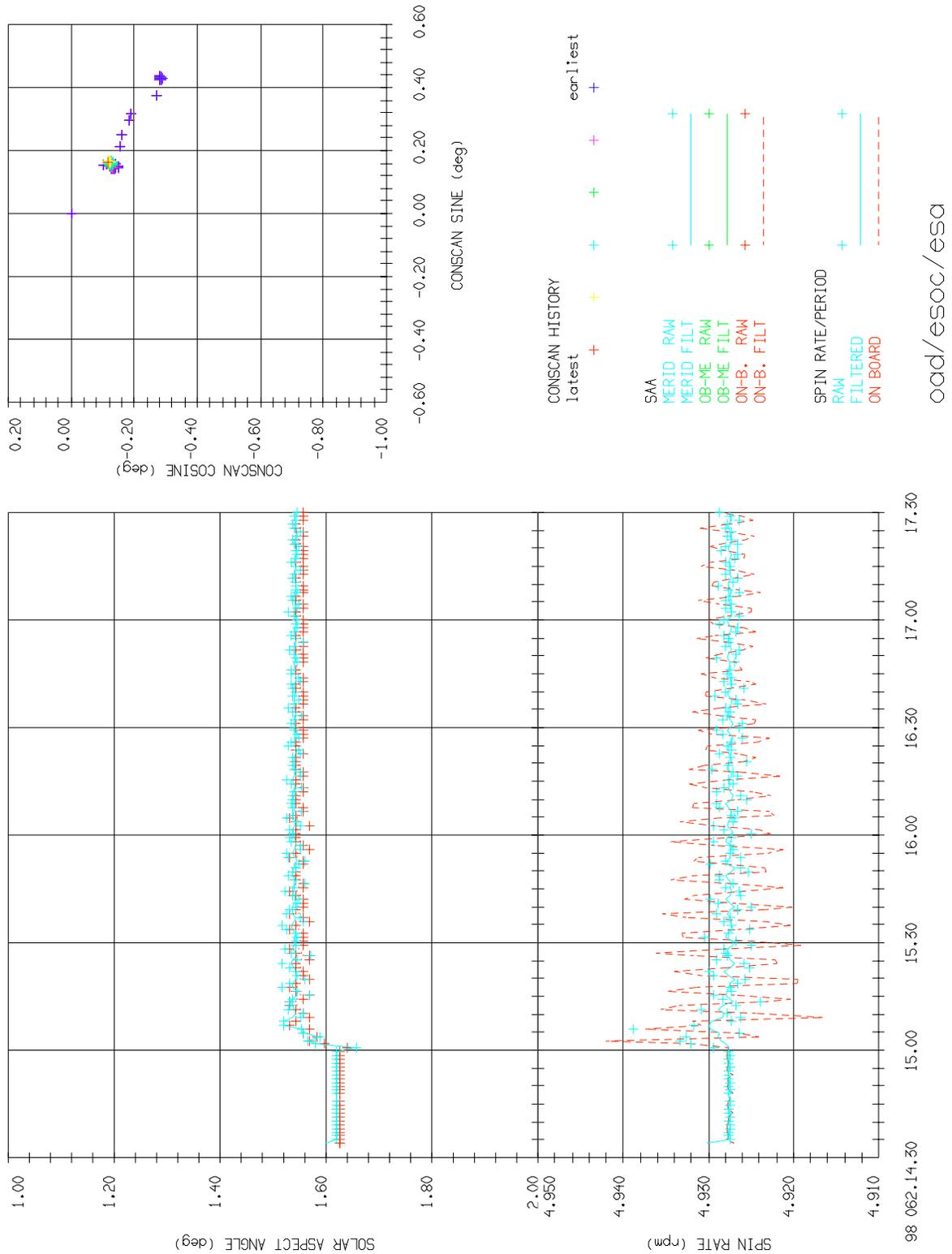


Figure C. 12: Real-Time Monitor Plot of Opposition 5 Slew 11

Appendix D MPFs from Resimulation of Actual Manoeuvres

```
C*****
C NR COMMAND FILE FOR SIMULATING PULSED FIRING OR RHUMB LINE SLEW MANOEUVRES
C
C CKC, 20-FEB-1998
C Resimulation of Opp5 slew 0
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:02:20 23.17.18

START TIME: 980220:043005.70
STOP TIME: 980220:043635.30

SPACE-CRAFT ATTITUDE IN MES1950

	AT START TIME	AT STOP TIME	
RIGHT ASCENSION	341.834	341.505	DEG
DECLINATION	-12.827	-12.833	DEG
SUN ASPECT ANGLE	1.898	1.582	DEG
EARTH ASPECT ANGLE	0.304	0.020	DEG
SPIN PERIOD	12.175	12.175	SEC

DELTA-V IMPARTED TO THE SPACECRAFT

X COMPONENT	0.004 M/S
Y COMPONENT	-0.001 M/S
Z COMPONENT	-0.001 M/S
ABSOLUTE VALUE	0.005 M/S
COMPONENT IN EARTH DIRECTION	-0.005 M/S

MASS PROPERTIES OF SPACECRAFT

	AT START TIME	AT STOP TIME	
MASS	344.070	344.069	KG
Z MOMENT OF INERTIA	534.980	534.980	KGMS

MANOEUVRE PARAMETERS

```
OPEN LOOP THRUSTERS      : 08 LA1
THRUSTER FREQUENCY      : 1/2
THRUSTER PULSE WIDTH    : 3.16 DEG
THRUSTER FIRING MODE    : ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 16
TELECOMMANDED PHASE DELAY : 797
```

SPACECRAFT PARAMETERS

	AT START TIME	AT STOP TIME	
TANK PRESSURE	7.523	7.523	BAR
FUEL LEFT	11.030	11.029	KG
FUEL RATE	0.0034	0.0034	G/S
AXIAL FORCE COMPONENT	0.0041	0.0041	NEWTON
AXIAL TORQUE COMPONENT	0.0000	0.0000	N METRE
RADIAL FORCE COMPONENT	0.0000	0.0000	NEWTON
AZIMUTH OF FORCE	-177.249	-177.249	DEG
RADIAL TORQUE COMPONENT	0.0040	0.0040	N METRE
AZIMUTH OF TORQUE	9.969	9.969	DEG

FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE

CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.158, AZI -0.12900 SEC
FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC

RHUMB ANGLE 10.042 DEG PATH LENGTH 0.321 DEG

```
C*****
C NR COMMAND FILE FOR SIMULATING PULSED FIRING OR RHUMB LINE SLEW MANOEUVRES
C
C CKC, 21-FEB-1998
C Resimulation of Opp5 slew 1
C Target attitude for this manoeuvre = 341.28,-13.15
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:02:21 22.37.53
=====

START TIME: 980221:192951.45
STOP TIME: 980221:193734.10

SPACE-CRAFT ATTITUDE IN MES1950

	AT START TIME	AT STOP TIME	
RIGHT ASCENSION	341.491	341.280	DEG
DECLINATION	-12.876	-13.195	DEG
SUN ASPECT ANGLE	1.610	1.532	DEG
EARTH ASPECT ANGLE	0.324	0.349	DEG
SPIN PERIOD	12.175	12.175	SEC

DELTA-V IMPARTED TO THE SPACECRAFT

X COMPONENT	0.005 M/S
Y COMPONENT	-0.002 M/S
Z COMPONENT	-0.001 M/S
ABSOLUTE VALUE	0.005 M/S
COMPONENT IN EARTH DIRECTION	-0.005 M/S

MASS PROPERTIES OF SPACECRAFT

	AT START TIME	AT STOP TIME	
MASS	344.069	344.067	KG
Z MOMENT OF INERTIA	534.980	534.980	KGMS

MANOEUVRE PARAMETERS

```
OPEN LOOP THRUSTERS : 08 LA1
THRUSTER FREQUENCY : 1/2
THRUSTER PULSE WIDTH : 3.16 DEG
THRUSTER FIRING MODE : ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 19
TELECOMMANDED PHASE DELAY : 980
```

SPACECRAFT PARAMETERS

	AT START TIME	AT STOP TIME	
TANK PRESSURE	7.515	7.514	BAR
FUEL LEFT	11.029	11.027	KG
FUEL RATE	0.0034	0.0034	G/S
AXIAL FORCE COMPONENT	0.0040	0.0040	NEWTON
AXIAL TORQUE COMPONENT	0.0000	0.0000	N METRE
RADIAL FORCE COMPONENT	0.0000	0.0000	NEWTON
AZIMUTH OF FORCE	-112.912	-112.912	DEG
RADIAL TORQUE COMPONENT	0.0040	0.0040	N METRE
AZIMUTH OF TORQUE	77.824	77.824	DEG

FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.153, AZI -0.01000 SEC
FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

RHUMB ANGLE 78.197 DEG PATH LENGTH 0.380 DEG

```
C*****
C NR COMMAND FILE FOR SIMULATING PULSED FIRING OR RHUMB LINE SLEW MANOEUVRES
C
C CKC, 22-FEB-1998
C Resimulation of Opp5 slew 2
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:02:22 23.14.03

START TIME: 980222:192952.53
 STOP TIME: 980222:193533.43

SPACE-CRAFT ATTITUDE IN MES1950

	AT START TIME	AT STOP TIME	
RIGHT ASCENSION	341.274	341.083	DEG
DECLINATION	-13.213	-13.419	DEG
SUN ASPECT ANGLE	1.568	1.534	DEG
EARTH ASPECT ANGLE	0.461	0.546	DEG
SPIN PERIOD	12.175	12.175	SEC

DELTA-V IMPARTED TO THE SPACECRAFT

X COMPONENT	0.004 M/S
Y COMPONENT	-0.001 M/S
Z COMPONENT	-0.001 M/S
ABSOLUTE VALUE	0.004 M/S
COMPONENT IN EARTH DIRECTION	-0.004 M/S

MASS PROPERTIES OF SPACECRAFT

	AT START TIME	AT STOP TIME	
MASS	344.067	344.066	KG
Z MOMENT OF INERTIA	534.980	534.980	KGMS

MANOEUVRE PARAMETERS

```
OPEN LOOP THRUSTERS      : 08 LA1
THRUSTER FREQUENCY      : 1/2
THRUSTER PULSE WIDTH    : 3.16 DEG
THRUSTER FIRING MODE    : ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 14
TELECOMMANDED PHASE DELAY : 979
```

SPACECRAFT PARAMETERS

	AT START TIME	AT STOP TIME	
TANK PRESSURE	7.514	7.514	BAR
FUEL LEFT	11.027	11.026	KG
FUEL RATE	0.0034	0.0034	G/S
AXIAL FORCE COMPONENT	0.0040	0.0040	NEWTON
AXIAL TORQUE COMPONENT	0.0000	0.0000	N METRE
RADIAL FORCE COMPONENT	0.0000	0.0000	NEWTON
AZIMUTH OF FORCE	-113.264	-113.264	DEG
RADIAL TORQUE COMPONENT	0.0040	0.0040	N METRE
AZIMUTH OF TORQUE	82.617	82.617	DEG

FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.151, AZI +0.16400 SEC
                               FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

RHUMB ANGLE 82.997 DEG PATH LENGTH 0.278 DEG

```
C*****
C NR COMMAND FILE FOR SIMULATING PULSED FIRING OR RHUMB LINE SLEW MANOEUVRES
C
C CKC, 22-FEB-1998
C Resimulation of Opp5 slew 3 (planned before execution of slew 2)
C Target attitude = 340.86, -13.54
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:02:24 00.23.42
=====

START TIME: 980223:195945.63
STOP TIME: 980223:200502.18

SPACE-CRAFT ATTITUDE IN MES1950

	AT START TIME	AT STOP TIME	
RIGHT ASCENSION	341.069	340.849	DEG
DECLINATION	-13.414	-13.577	DEG
SUN ASPECT ANGLE	1.560	1.532	DEG
EARTH ASPECT ANGLE	0.609	0.672	DEG
SPIN PERIOD	12.175	12.175	SEC

DELTA-V IMPARTED TO THE SPACECRAFT

X COMPONENT	0.003 M/S
Y COMPONENT	-0.001 M/S
Z COMPONENT	-0.001 M/S
ABSOLUTE VALUE	0.004 M/S
COMPONENT IN EARTH DIRECTION	-0.004 M/S

MASS PROPERTIES OF SPACECRAFT

	AT START TIME	AT STOP TIME	
MASS	344.066	344.065	KG
Z MOMENT OF INERTIA	534.980	534.980	KGMS

MANOEUVRE PARAMETERS

```
OPEN LOOP THRUSTERS : 08 LA1
THRUSTER FREQUENCY : 1/2
THRUSTER PULSE WIDTH : 3.16 DEG
THRUSTER FIRING MODE : ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 13
TELECOMMANDED PHASE DELAY : 991
```

SPACECRAFT PARAMETERS

	AT START TIME	AT STOP TIME	
TANK PRESSURE	7.514	7.514	BAR
FUEL LEFT	11.026	11.025	KG
FUEL RATE	0.0034	0.0034	G/S
AXIAL FORCE COMPONENT	0.0040	0.0040	NEWTON
AXIAL TORQUE COMPONENT	0.0000	0.0000	N METRE
RADIAL FORCE COMPONENT	0.0000	0.0000	NEWTON
AZIMUTH OF FORCE	-109.045	-109.045	DEG
RADIAL TORQUE COMPONENT	0.0042	0.0042	N METRE
AZIMUTH OF TORQUE	83.524	83.524	DEG

FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.201, AZI +0.05200 SEC
FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

RHUMB ANGLE 83.921 DEG PATH LENGTH 0.269 DEG

```
C*****
C NR COMMAND FILE FOR SIMULATING PULSED FIRING OR RHUMB LINE SLEW MANOEUVRES
C
C CKC, 24-FEB-1998
C Resimulation of Opp5 slew 4
C - planned before execution of slew 2 with observations after slew 1
C Target attitude = 340.65, -13.62
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:02:25 00.07.53
=====

START TIME: 980224:192954.69
STOP TIME: 980224:193422.54

SPACE-CRAFT ATTITUDE IN MES1950

	AT START TIME	AT STOP TIME	
RIGHT ASCENSION	340.826	340.616	DEG
DECLINATION	-13.599	-13.678	DEG
SUN ASPECT ANGLE	1.578	1.535	DEG
EARTH ASPECT ANGLE	0.734	0.743	DEG
SPIN PERIOD	12.175	12.175	SEC

DELTA-V IMPARTED TO THE SPACECRAFT

X COMPONENT	0.003 M/S
Y COMPONENT	-0.001 M/S
Z COMPONENT	-0.001 M/S
ABSOLUTE VALUE	0.003 M/S
COMPONENT IN EARTH DIRECTION	-0.003 M/S

MASS PROPERTIES OF SPACECRAFT

	AT START TIME	AT STOP TIME	
MASS	344.065	344.064	KG
Z MOMENT OF INERTIA	534.980	534.980	KGMS

MANOEUVRE PARAMETERS

```
OPEN LOOP THRUSTERS      : 08 LA1
THRUSTER FREQUENCY      : 1/2
THRUSTER PULSE WIDTH    : 3.16 DEG
THRUSTER FIRING MODE    : ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 11
TELECOMMANDED PHASE DELAY : 975
```

SPACECRAFT PARAMETERS

	AT START TIME	AT STOP TIME	
TANK PRESSURE	7.514	7.514	BAR
FUEL LEFT	11.025	11.024	KG
FUEL RATE	0.0034	0.0034	G/S
AXIAL FORCE COMPONENT	0.0040	0.0040	NEWTON
AXIAL TORQUE COMPONENT	0.0000	0.0000	N METRE
RADIAL FORCE COMPONENT	0.0000	0.0000	NEWTON
AZIMUTH OF FORCE	-114.670	-114.670	DEG
RADIAL TORQUE COMPONENT	0.0040	0.0040	N METRE
AZIMUTH OF TORQUE	78.166	78.166	DEG

FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.159, AZI +0.06100 SEC
                           FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

RHUMB ANGLE 78.540 DEG PATH LENGTH 0.219 DEG

```
C*****
C NR COMMAND FILE FOR SIMULATING PULSED FIRING OR RHUMB LINE SLEW MANOEUVRES
C
C CKC, 26-FEB-1998
C Resimulation of Opp5 slew 5
C - planned before execution of slew 4 using observations from slew 3
C Target attitude = 340.43, -13.68
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:02:26 01.05.05
=====

START TIME: 980225:192955.77
STOP TIME: 980225:193359.27

SPACE-CRAFT ATTITUDE IN MES1950

	AT START TIME	AT STOP TIME	
RIGHT ASCENSION	340.574	340.356	DEG
DECLINATION	-13.703	-13.724	DEG
SUN ASPECT ANGLE	1.586	1.524	DEG
EARTH ASPECT ANGLE	0.794	0.758	DEG
SPIN PERIOD	12.175	12.175	SEC

DELTA-V IMPARTED TO THE SPACECRAFT

X COMPONENT	0.003 M/S
Y COMPONENT	-0.001 M/S
Z COMPONENT	-0.001 M/S
ABSOLUTE VALUE	0.003 M/S
COMPONENT IN EARTH DIRECTION	-0.003 M/S

MASS PROPERTIES OF SPACECRAFT

	AT START TIME	AT STOP TIME	
MASS	344.064	344.063	KG
Z MOMENT OF INERTIA	534.980	534.980	KGMS

MANOEUVRE PARAMETERS

```
OPEN LOOP THRUSTERS      : 08 LA1
THRUSTER FREQUENCY      : 1/2
THRUSTER PULSE WIDTH    : 3.16 DEG
THRUSTER FIRING MODE    : ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 10
TELECOMMANDED PHASE DELAY : 952
```

SPACECRAFT PARAMETERS

	AT START TIME	AT STOP TIME	
TANK PRESSURE	7.514	7.514	BAR
FUEL LEFT	11.024	11.023	KG
FUEL RATE	0.0034	0.0034	G/S
AXIAL FORCE COMPONENT	0.0040	0.0040	NEWTON
AXIAL TORQUE COMPONENT	0.0000	0.0000	N METRE
RADIAL FORCE COMPONENT	0.0000	0.0000	NEWTON
AZIMUTH OF FORCE	-122.756	-122.756	DEG
RADIAL TORQUE COMPONENT	0.0043	0.0043	N METRE
AZIMUTH OF TORQUE	72.711	72.711	DEG

FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.242, AZI +0.15000 SEC
                               FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

RHUMB ANGLE 73.102 DEG PATH LENGTH 0.213 DEG

```

C*****
C NR COMMAND FILE FOR SIMULATING PULSED FIRING OR RHUMB LINE SLEW MANOEUVRES
C
C CKC, 26-FEB-1998
C Resimulation of Opp5 slew 6
C - planned before execution of slew 4 using observations from slew 3 and
C simulation of slew 5
C Target attitude = 340.20, -13.69
C*****
    
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:02:26 23.01.01

```

START TIME: 980226:192956.85
STOP TIME: 980226:193400.35
    
```

SPACE-CRAFT ATTITUDE IN MES1950

	AT START TIME	AT STOP TIME	
RIGHT ASCENSION	340.332	340.131	DEG
DECLINATION	-13.747	-13.741	DEG
SUN ASPECT ANGLE	1.588	1.535	DEG
EARTH ASPECT ANGLE	0.806	0.750	DEG
SPIN PERIOD	12.175	12.175	SEC

DELTA-V IMPARTED TO THE SPACECRAFT

X COMPONENT	0.003 M/S
Y COMPONENT	-0.001 M/S
Z COMPONENT	-0.001 M/S
ABSOLUTE VALUE	0.003 M/S
COMPONENT IN EARTH DIRECTION	-0.003 M/S

MASS PROPERTIES OF SPACECRAFT

	AT START TIME	AT STOP TIME	
MASS	344.063	344.062	KG
Z MOMENT OF INERTIA	534.980	534.980	KGMS

MANOEUVRE PARAMETERS

```

OPEN LOOP THRUSTERS      : 08 LA1
THRUSTER FREQUENCY      : 1/2
THRUSTER PULSE WIDTH    : 3.16 DEG
THRUSTER FIRING MODE    : ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 10
TELECOMMANDED PHASE DELAY : 966
    
```

SPACECRAFT PARAMETERS

	AT START TIME	AT STOP TIME	
TANK PRESSURE	7.513	7.513	BAR
FUEL LEFT	11.023	11.022	KG
FUEL RATE	0.0034	0.0034	G/S
AXIAL FORCE COMPONENT	0.0040	0.0040	NEWTON
AXIAL TORQUE COMPONENT	0.0000	0.0000	N METRE
RADIAL FORCE COMPONENT	0.0000	0.0000	NEWTON
AZIMUTH OF FORCE	-117.834	-117.834	DEG
RADIAL TORQUE COMPONENT	0.0040	0.0040	N METRE
AZIMUTH OF TORQUE	73.819	73.819	DEG

FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE

```

CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.140, AZI +0.02100 SEC
                               FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
    
```

```

RHUMB ANGLE 74.178 DEG PATH LENGTH 0.195 DEG
    
```

```
C*****
C NR COMMAND FILE FOR SIMULATING PULSED FIRING OR RHUMB LINE SLEW MANOEUVRES
C
C CKC, 26-FEB-1998
C Resimulation of Opp5 slew 7
C - planned using observations from end of slew 6
C Target attitude = 339.97, -13.68
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:02:28 01.00.20
=====

START TIME: 980227:195949.95
STOP TIME: 980227:200329.10

SPACE-CRAFT ATTITUDE IN MES1950

	AT START TIME	AT STOP TIME	
RIGHT ASCENSION	340.114	339.940	DEG
DECLINATION	-13.764	-13.694	DEG
SUN ASPECT ANGLE	1.605	1.515	DEG
EARTH ASPECT ANGLE	0.803	0.685	DEG
SPIN PERIOD	12.175	12.175	SEC

DELTA-V IMPARTED TO THE SPACECRAFT

X COMPONENT	0.002 M/S
Y COMPONENT	-0.001 M/S
Z COMPONENT	-0.001 M/S
ABSOLUTE VALUE	0.002 M/S
COMPONENT IN EARTH DIRECTION	-0.002 M/S

MASS PROPERTIES OF SPACECRAFT

	AT START TIME	AT STOP TIME	
MASS	344.062	344.061	KG
Z MOMENT OF INERTIA	534.980	534.980	KGMS

MANOEUVRE PARAMETERS

```
OPEN LOOP THRUSTERS      : 08 LA1
THRUSTER FREQUENCY      : 1/2
THRUSTER PULSE WIDTH    : 3.16 DEG
THRUSTER FIRING MODE    : ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 9
TELECOMMANDED PHASE DELAY : 928
```

SPACECRAFT PARAMETERS

	AT START TIME	AT STOP TIME	
TANK PRESSURE	7.513	7.513	BAR
FUEL LEFT	11.022	11.021	KG
FUEL RATE	0.0034	0.0034	G/S
AXIAL FORCE COMPONENT	0.0040	0.0040	NEWTON
AXIAL TORQUE COMPONENT	0.0000	0.0000	N METRE
RADIAL FORCE COMPONENT	0.0000	0.0000	NEWTON
AZIMUTH OF FORCE	-131.193	-131.193	DEG
RADIAL TORQUE COMPONENT	0.0042	0.0042	N METRE
AZIMUTH OF TORQUE	60.282	60.282	DEG

FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.192, AZI +0.01500 SEC
                           FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

RHUMB ANGLE 60.624 DEG PATH LENGTH 0.183 DEG

```
C*****
C NR COMMAND FILE FOR SIMULATING PULSED FIRING OR RHUMB LINE SLEW MANOEUVRES
C
C CKC, 28-FEB-1998
C Resimulation of Opposition 5 slew 8
C - planned using observations from end of slew 6 and simulation of slew 7
C Target attitude = 339.72, -13.63
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:03:01 00.20.04

```
START TIME: 980228:192959.01
STOP TIME: 980228:193451.21
```

SPACE-CRAFT ATTITUDE IN MES1950

```
-----
                AT START TIME          AT STOP TIME
RIGHT ASCENSION      339.929            339.706    DEG
DECLINATION          -13.713            -13.663    DEG
SUN ASPECT ANGLE     1.581              1.532    DEG
EARTH ASPECT ANGLE   0.750              0.629    DEG
SPIN PERIOD          12.175             12.175    SEC
```

DELTA-V IMPARTED TO THE SPACECRAFT

```
-----
X COMPONENT           0.003 M/S
Y COMPONENT           -0.001 M/S
Z COMPONENT           -0.001 M/S
ABSOLUTE VALUE        0.003 M/S
COMPONENT IN EARTH DIRECTION -0.003 M/S
```

MASS PROPERTIES OF SPACECRAFT

```
-----
                AT START TIME          AT STOP TIME
MASS                 344.061            344.060    KG
Z MOMENT OF INERTIA  534.980            534.980   KGMS
```

MANOEUVRE PARAMETERS

```
-----
OPEN LOOP THRUSTERS      : 08 LA1
THRUSTER FREQUENCY      : 1/2
THRUSTER PULSE WIDTH    : 3.16 DEG
THRUSTER FIRING MODE    : ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 12
TELECOMMANDED PHASE DELAY : 977
```

SPACECRAFT PARAMETERS

```
-----
                AT START TIME          AT STOP TIME
TANK PRESSURE         7.513              7.513    BAR
FUEL LEFT              11.021             11.020    KG
FUEL RATE              0.0034             0.0034   G/S
AXIAL FORCE COMPONENT   0.0040             0.0040   NEWTON
AXIAL TORQUE COMPONENT 0.0000             0.0000   N METRE
RADIAL FORCE COMPONENT  0.0000             0.0000   NEWTON
AZIMUTH OF FORCE        -113.967            -113.967  DEG
RADIAL TORQUE COMPONENT 0.0038             0.0038   N METRE
AZIMUTH OF TORQUE      76.917              76.917   DEG
FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE
```

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.079, AZI -0.00500 SEC
                               FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

```
RHUMB ANGLE  77.261 DEG  PATH LENGTH  0.223 DEG
```

```
C*****
C NR COMMAND FILE FOR SIMULATING PULSED FIRING OR RHUMB LINE SLEW MANOEUVRES
C
C CKC, 1-MAR-1998
C Resimulation of Opposition 5 slew 9
C - planned using observations from end of slew 7 and simulation of slew 8
C Target attitude = 339.49, -13.55
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:03:01 23.44.49

```
START TIME: 980301:193000.09
STOP TIME: 980301:193427.94
```

SPACE-CRAFT ATTITUDE IN MES1950

	AT START TIME	AT STOP TIME	
RIGHT ASCENSION	339.703	339.525	DEG
DECLINATION	-13.679	-13.600	DEG
SUN ASPECT ANGLE	1.596	1.540	DEG
EARTH ASPECT ANGLE	0.700	0.557	DEG
SPIN PERIOD	12.175	12.175	SEC

DELTA-V IMPARTED TO THE SPACECRAFT

X COMPONENT	0.003 M/S
Y COMPONENT	-0.001 M/S
Z COMPONENT	-0.001 M/S
ABSOLUTE VALUE	0.003 M/S
COMPONENT IN EARTH DIRECTION	-0.003 M/S

MASS PROPERTIES OF SPACECRAFT

	AT START TIME	AT STOP TIME	
MASS	344.060	344.059	KG
Z MOMENT OF INERTIA	534.980	534.980	KGMS

MANOEUVRE PARAMETERS

```
OPEN LOOP THRUSTERS : 08 LA1
THRUSTER FREQUENCY : 1/2
THRUSTER PULSE WIDTH : 3.16 DEG
THRUSTER FIRING MODE : ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 11
TELECOMMANDED PHASE DELAY : 965
```

SPACECRAFT PARAMETERS

	AT START TIME	AT STOP TIME	
TANK PRESSURE	7.513	7.513	BAR
FUEL LEFT	11.020	11.019	KG
FUEL RATE	0.0034	0.0034	G/S
AXIAL FORCE COMPONENT	0.0040	0.0040	NEWTON
AXIAL TORQUE COMPONENT	0.0000	0.0000	N METRE
RADIAL FORCE COMPONENT	0.0000	0.0000	NEWTON
AZIMUTH OF FORCE	-118.186	-118.186	DEG
RADIAL TORQUE COMPONENT	0.0035	0.0035	N METRE
AZIMUTH OF TORQUE	72.314	72.314	DEG

FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.008, AZI -0.01800 SEC
FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

```
RHUMB ANGLE 72.627 DEG PATH LENGTH 0.190 DEG
```

```
C*****
C NR COMMAND FILE FOR SIMULATING PULSED FIRING OR RHUMB LINE SLEW MANOEUVRES
C
C CKC, 1-MAR-1998
C Resimulation of Opposition 5 slew 10
C - planned using observations from end of slew 8 and simulation of slew 9
C Target attitude = 339.25, -13.44
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:03:02 21.10.45

```
START TIME: 980302:150008.96
STOP TIME: 980302:150614.21
```

SPACE-CRAFT ATTITUDE IN MES1950

```
-----
                AT START TIME          AT STOP TIME
RIGHT ASCENSION      339.510          339.233    DEG
DECLINATION          -13.607          -13.499    DEG
SUN ASPECT ANGLE     1.587            1.556    DEG
EARTH ASPECT ANGLE   0.617            0.415    DEG
SPIN PERIOD          12.175           12.175    SEC
```

DELTA-V IMPARTED TO THE SPACECRAFT

```
-----
X COMPONENT           0.004 M/S
Y COMPONENT           -0.001 M/S
Z COMPONENT           -0.001 M/S
ABSOLUTE VALUE        0.004 M/S
COMPONENT IN EARTH DIRECTION -0.004 M/S
```

MASS PROPERTIES OF SPACECRAFT

```
-----
                AT START TIME          AT STOP TIME
MASS                 344.059          344.058    KG
Z MOMENT OF INERTIA  534.980          534.980   KGMS
```

MANOEUVRE PARAMETERS

```
-----
OPEN LOOP THRUSTERS      : 08 LA1
THRUSTER FREQUENCY      : 1/2
THRUSTER PULSE WIDTH    : 3.16 DEG
THRUSTER FIRING MODE    : ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 15
TELECOMMANDED PHASE DELAY : 994
```

SPACECRAFT PARAMETERS

```
-----
                AT START TIME          AT STOP TIME
TANK PRESSURE         7.513            7.512    BAR
FUEL LEFT              11.019           11.018    KG
FUEL RATE              0.0034           0.0034   G/S
AXIAL FORCE COMPONENT   0.0040           0.0040   NEWTON
AXIAL TORQUE COMPONENT 0.0000           0.0000   N METRE
RADIAL FORCE COMPONENT  0.0000           0.0000   NEWTON
AZIMUTH OF FORCE        -107.990          -107.990  DEG
RADIAL TORQUE COMPONENT 0.0039           0.0039   N METRE
AZIMUTH OF TORQUE      83.603            83.603   DEG
FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE
```

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.119, AZI +0.01900 SEC
                               FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

```
RHUMB ANGLE 83.960 DEG PATH LENGTH 0.290 DEG
```

```
C*****
C NR COMMAND FILE FOR SIMULATING PULSED FIRING OR RHUMB LINE SLEW MANOEUVRES
C
C CKC, 3-MAR-1998
C Resimulation of Opposition 5 slew 11
C - planned using observations from end of slew 10
C Target attitude = 339.00, -13.29
C*****
```

ULYSSES MANOEUVRE PREDICTION COMPUTED ON 98:03:03 22.01.17

```
START TIME: 980303:150010.04
STOP TIME: 980303:150639.64
```

SPACE-CRAFT ATTITUDE IN MES1950

```
-----
                AT START TIME          AT STOP TIME
RIGHT ASCENSION      339.265            338.998    DEG
DECLINATION          -13.520            -13.303    DEG
SUN ASPECT ANGLE     1.608              1.520     DEG
EARTH ASPECT ANGLE   0.517              0.200     DEG
SPIN PERIOD          12.175             12.175    SEC
```

DELTA-V IMPARTED TO THE SPACECRAFT

```
-----
X COMPONENT           0.004 M/S
Y COMPONENT          -0.002 M/S
Z COMPONENT          -0.001 M/S
ABSOLUTE VALUE        0.005 M/S
COMPONENT IN EARTH DIRECTION -0.005 M/S
```

MASS PROPERTIES OF SPACECRAFT

```
-----
                AT START TIME          AT STOP TIME
MASS                 344.058            344.057    KG
Z MOMENT OF INERTIA  534.980            534.980   KGMS
```

MANOEUVRE PARAMETERS

```
-----
OPEN LOOP THRUSTERS      : 08 LA1
THRUSTER FREQUENCY      : 1/2
THRUSTER PULSE WIDTH    : 3.16 DEG
THRUSTER FIRING MODE    : ATTITUDE SLEW
NO. OF FIRING SPIN PERIODS : 16
TELECOMMANDED PHASE DELAY : 963
```

SPACECRAFT PARAMETERS

```
-----
                AT START TIME          AT STOP TIME
TANK PRESSURE         7.512              7.512     BAR
FUEL LEFT             11.018             11.017    KG
FUEL RATE             0.0034             0.0034   G/S
AXIAL FORCE COMPONENT  0.0040             0.0040   NEWTON
AXIAL TORQUE COMPONENT 0.0000             0.0000   N METRE
RADIAL FORCE COMPONENT 0.0000             0.0000   NEWTON
AZIMUTH OF FORCE       -118.889            -118.889  DEG
RADIAL TORQUE COMPONENT 0.0043             0.0043   N METRE
AZIMUTH OF TORQUE     74.627             74.627   DEG
FUEL RATE, FORCES AND TORQUES ARE AVERAGES OVER ONE DUTY CYCLE
```

```
CALIB COEFFS. PULSE 1 TORQUE : AXL * 0.000, RAD * 1.224, AZI +0.08400 SEC
                               FORCE : AXL * 1.278, RAD * 1.000, AZI +0.00000 SEC
```

```
RHUMB ANGLE 75.006 DEG PATH LENGTH 0.339 DEG
```